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Soil and Crop Studies

at the BIG SPRING (TEXAS) FIELD STATION

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Production Research Report No. 1

UNITED STATES DEPARTMENT OF AGRICULTURE

In cooperation with the

Texas Agricultural Experiment Station

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Washington, D. C. Issued March 1957

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Soil and Crop Studies

at the BIG SPRING (TEXAS) FIELD STATION

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THE AREA AND ITS AGRICULTURAL PROBLEM

The area served by the Big Spring Field Station is divided into two general classifications—ranching and farming. The station is located 1 mile north of Big Spring, Tex., which is practically on the dividing line between the northern edge of the Edwards Plateau and the southern edge of the Llano Estacado, or Staked Plains. This line marks in a general way the dividing line between the ranching and the farming sections of the area. The elevation of the station is 2,400 feet.

There is no row-crop farming of consequence on the Edwards Plateau except for a few localities where irrigation water is available. Most soils are shallow, more or less rocky, and of such low water-holding capacity that profitable crops cannot be produced regularly with the limited rainfall. The Plateau does, however, produce enough grass to support a large number of cattle, sheep, and goats. This livestock industry contributes materially to the economic stability of the region.

The farming section extends northward from the Edwards Plateau. The principal soil type is Amarillo fine sandy loam. The topography is generally level, making it well suited to farming operations.

The first white man settled in Howard County, in which the station is located, in 1877. The county and surrounding area remained almost entirely in the control of ranchers until after the turn of the century. It was generally thought that the section would not produce any crop other than grass because of the low rainfall. After 1900, settlers began coming into the section, and the change from a ranching system based on grazing to one where crop growing was a major enterprise was soon under way. Diversified farming and ranching gradually replaced the ranch economy.

The Big Spring Field Station was established in 1915, mainly to assist farmers with the problems in connection with crop production in the area. Later, work on the utilization of homegrown feed crops was started in cooperation with the Bureau of Animal Industry of the United States Department of Agriculture and the Texas Agricultural Experiment Station. This phase of the work is discussed in other publications (*1*, *2*).[1]

The greatest problem is that of trying to produce profitable crops with limited and often poorly distributed rainfall. This involves the production of adapted crops and varieties under tillage and planting practices that make the best use of the moisture normally available and the combination of such crops into workable cropping systems. Soil type as well as climatic factors must be taken into consideration.

Another important problem is wind erosion. Reducing wind erosion damage is as important to profitable crop production as is conserving moisture. Rotations or cropping practices suitable for moisture conservation should be further evaluated for their effect on probable wind erosion damage. If fields are allowed to become eroded and the topsoil lost, moisture storage will not compensate for the reduction in soil productivity. Some crops that otherwise might be profitable are avoided, because they leave so little residue that danger of serious wind erosion damage is increased.

Another potentially important problem is that of organic matter depletion. Heavy losses of organic matter and nitrogen have taken place during the comparatively short time these soils have been under cultivation. Up to the present time this has not affected crop yields. It would seem, however, that the problem demands serious study before it becomes acute.

CLIMATE

The climatic data presented were obtained at the Big Spring Field Station. Temperatures and precipitation were measured with standard Weather Bureau equipment. Wind velocity was measured by an anemometer exposed at a height of 2 feet above the ground. Evaporation was measured in a Plant Industry type evaporation pan,

[1] Italic numbers in parentheses refer to Literature Cited, p. 26.

which is 6 feet in diameter and 24 inches deep, set 20 inches into the ground with the water maintained at approximately ground level.

Precipitation

Precipitation generally limits crop production in the section. Both the total quantity and its distribution are important. The total quantity received may be insufficient for crop production, or the distribution of larger quantities may be such that crops do not benefit greatly from it. The average monthly and annual precipitation, and the maximum and minimum quantities for each month and for the whole year are presented in table 1. Although the average precipitation is divided fairly evenly, any individual month may have a quantity ranging from zero or near zero to severa times the average quantity. The annual precipitation has ranged from 4.68 to 34.25 inches. Annual precipitation by months (appendix, table 24) emphasizes the extent to which much of the year's precipitation may be concentrated into a few months. Such periods may be too late in the season to benefit the current year's crops. The benefit from concentrations at more favorable periods of the year may be reduced by runoff and erosion from heavy rains during the period, or sometimes because the quantity entering the soil is more than the soil can hold within reach of crop roots.

The average precipitation by 10-day periods is shown in figure 1. In common with results reported from other southern experimental loca-

Table 1.—*Average monthly and annual precipitation, and monthly and annual maximum and minimum precipitations, Big Spring, Tex., 1916–53*

Item	Precipitation												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Average, 1916–53	0.65	0.70	0.95	1.51	2.72	2.19	1.77	2.07	2.10	1.98	0.86	0.80	18.31
Maximum	2.71	3.81	3.14	12.77	10.10	8.28	9.25	8.43	10.52	7.06	3.38	3.00	34.25
Minimum	.03	0	0	0	.08	0	.07	0	0	0	0	0	4.68

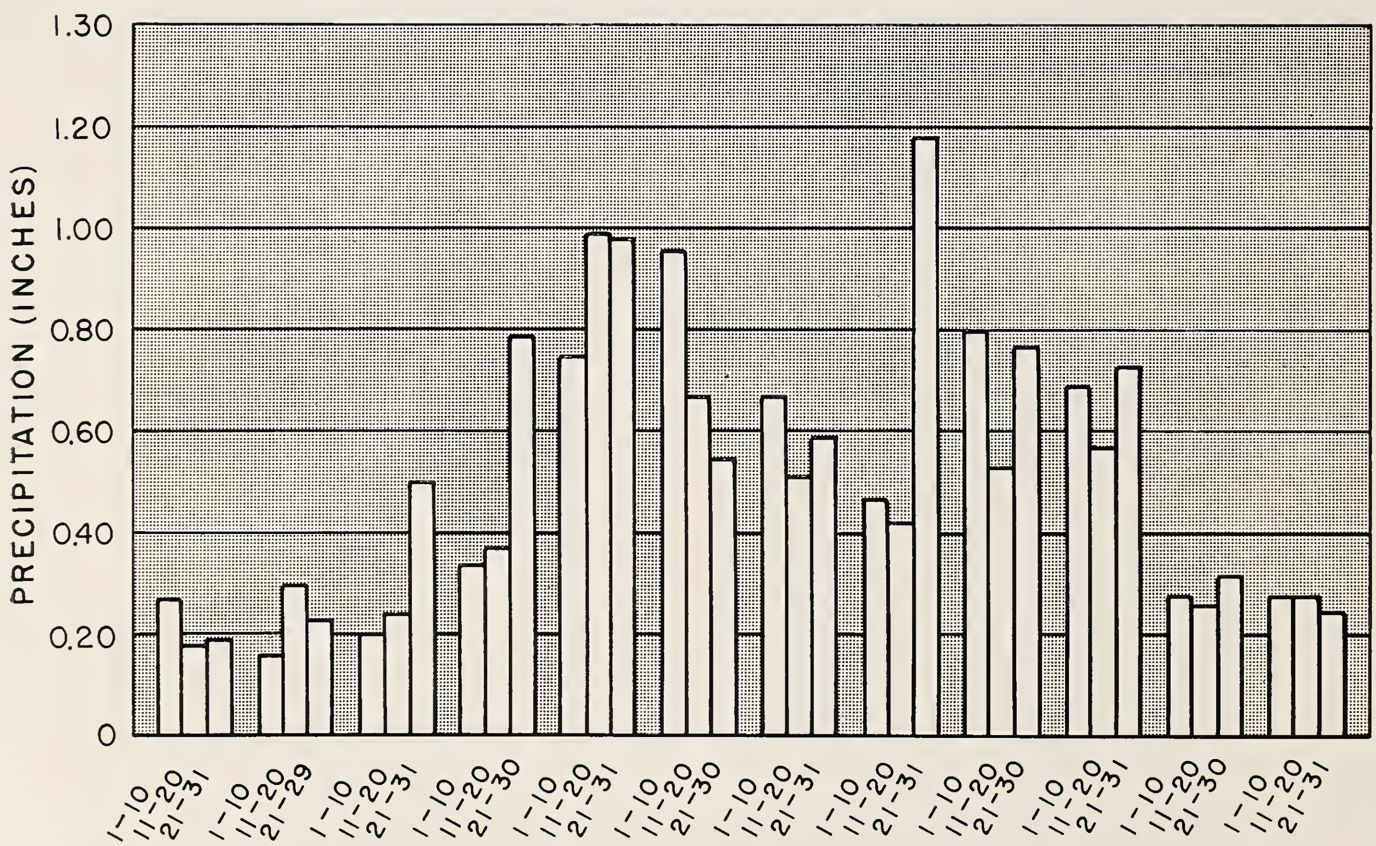


Figure 1.—Average precipitation by 10-day periods (average of 38 years' records), Big Spring, Tex., 1916–53.

tions, there is a summer period with relatively low rainfall. At Big Spring this period extends from early June to late August. The end of this period is often characterized by adequate and sometimes excessive rainfall, giving the last period in August the highest average precipitation of any period of the year. The portion of the year when rainfall is most likely to be favorable extends from the last period in April through the first period of June.

Evaporation

The average evaporation from a free-water surface for the 6 months, April–September, inclusive, was 54.76 inches (table 2). Average evaporation from October to March, inclusive, for a shorter period of years was 23.77 inches, making an annual total of 78.53 inches. During the growing season (April–September) the evaporation is almost 4½ times the precipitation. Detailed monthly and seasonal evaporation are given (appendix, table 25).

Temperature

Mean temperatures for the different months of the year are shown in table 2. The means for June, July, and August exceeded 80° F., and those for the winter months (December, January, and February) were below 45°.

The average maximum temperature for July and August was 95° F. Consistently high temperatures during the midsummer period when precipitation is relatively low (fig. 1) intensify crop production problems.

The average frost-free period was 222 days, extending from March 31 to November 8. The last killing frost in the spring is well in advance of the optimum date for planting field crops, but it may injure tender garden crops in some years. The last killing frost in spring damages peaches and apricots so regularly that these fruit crops cannot be produced economically. Field crops normally mature before the first killing frost in the fall, although there is occasional damage to crops that have been planted or have emerged very late. Late fall frosts make it possible to produce crops of early-maturing sorghums, even when planted after the middle of July.

Wind Velocity

Average wind velocities for the different months of the year are shown in figure 2. Highest monthly velocities occur in March and April when the soil has been made friable by freezing and thawing during the winter and when protective plant residues are at a minimum. The sandy nature of the soil and the fact that the best adapted crops leave relatively small quantities of residue make soil blowing in the early spring months an annual threat.

Mean velocities decrease after April and reach the low point for the year in October.

SOIL

The soil on the station is described by Templin [2] as follows:

> The soil on the rotation plots is Amarillo fine sandy loam and uniform in morphological characteristics, drainage, and topography. Although some slight movement of soil material by wind action probably has occurred, there is no visible evidence of this in the soil itself. I judge the rotation plots to be wholly suitable for studies of the effects of various long-continued cropping systems on the soil, and more suitable than those on any other of the U. S. Field Stations in the Southern Great Plains that is on sandy land.
>
> All of the Big Spring Field Station is Amarillo fine sandy loam, and an accurate and adequate soil map could be made by placing a single symbol standing for Amarillo fine sandy loam on any suitable base map of the station.
>
> The rotation plots are nearly level, with gradient of about ½ percent, the shape of surface being plane to very slightly concave. The soil is very slightly darker and less reddish and less sandy than modal Amarillo fine sandy loam but is well within the range of the type. To the north of the rotation plots, comprising the remainder of the cultivated area on the Field Station, the field is very slightly more sloping, with gradient of about 1 percent,

[2] Special survey of the Big Spring Field Station made in April 1947, by E. H. Templin, professor in charge of Soil Survey (cooperating with the U. S. Department of Agriculture), Texas Agricultural Experiment Station.

TABLE 2.—*Average mean, mean maximum, and mean minimum monthly, seasonal, and annual temperatures; and average monthly, seasonal, and annual evaporation, Big Spring, Tex., 1916–53*

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total or average: Apr.–Sept.	Total or average: Annual
Evaporation ... inches	[1] 3.10	[1] 3.27	[1] 5.23	7.68	8.75	10.15	10.64	10.12	7.42	[1] 5.79	[1] 3.67	[1] 2.71	54.76	78.53
Mean temperature ... °F	42	47	54	64	72	80	83	82	75	64	51	44	76	63
Mean maximum temperature °F	56	62	69	79	86	93	95	95	88	78	66	58	89	77
Mean minimum temperature °F	28	32	39	48	58	67	70	67	62	51	38	29	62	49

[1] 7-year average.

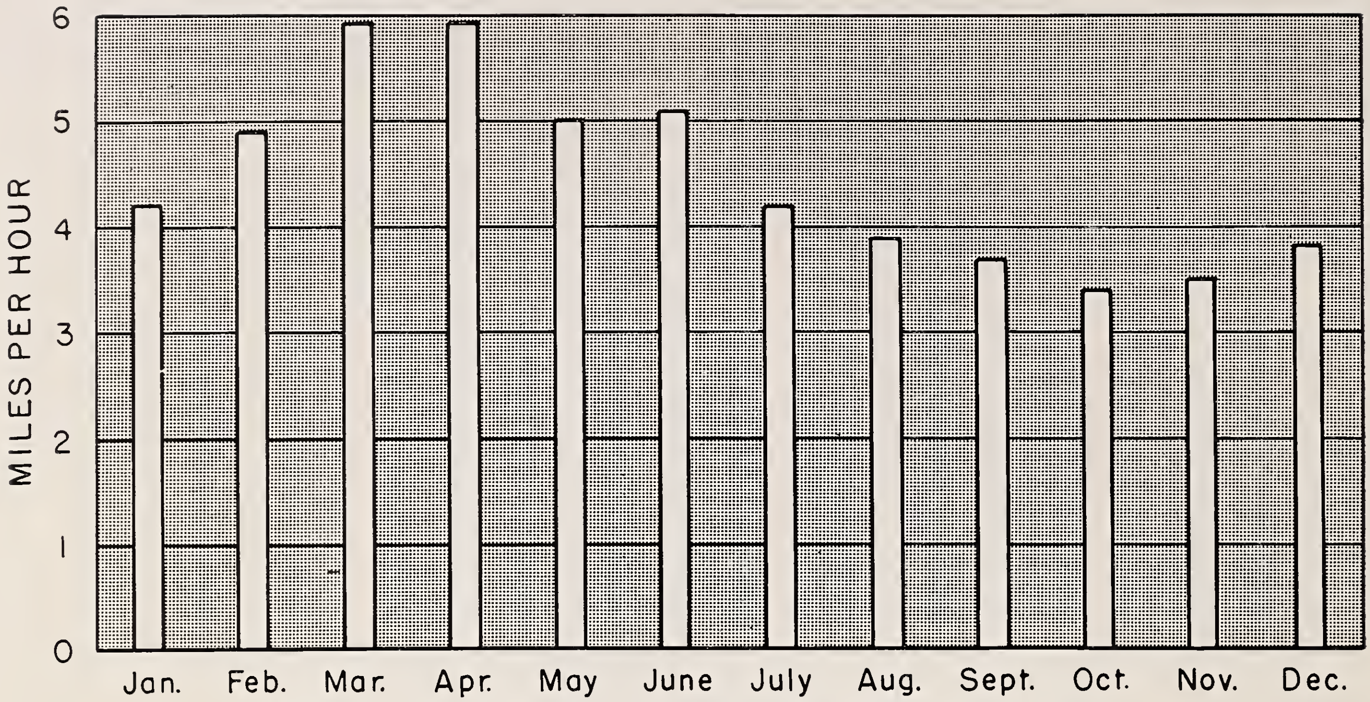


Figure 2.—Mean monthly wind velocities, Big Spring, Tex., 1916–53.

and the plane to weakly convex surface. There, the soil is slightly redder and is modal Amarillo fine sandy loam.

While the soil is in general very uniform, there are spots, locally termed "hot spots," where crops fire sooner than in the surrounding area. These spots are limited in area and irregular in occurrence and are not evidenced by surface conditions. They are associated with the presence of clay just below the plow layer. To keep comparisons valid, it is necessary to eliminate them when making comparisons between methods. Only a few of them appear in the crop rotation block.

The land occupied by the rotation and tillage plots was broken from native sod in 1906 and cropped to cotton and milo until the station was established.

PROCEDURE IN ROTATION AND TILLAGE EXPERIMENTS

Rotation and tillage experiments were conducted on 0.1 acre plots, 2×8 rods in size, and separated at the sides by 4-foot alleys and at the ends by 20-foot roadways. A diagram of the field as it was in 1947, before certain treatments were discontinued, is shown in figure 3. Each rotation occupied as many plots as there were years in the rotation. Tillage experiments were generally carried on continuously on the same plots. Rotations and tillage methods were arranged in the field so that treatments to be compared were as close together as was feasible.

Rotations and tillage methods, as they were conducted during most of the years (fig. 3), are given in detail (table 3).

No treatments were replicated, but crops of the same general character were grown under identical tillage practices, which amounted to approximate replication.

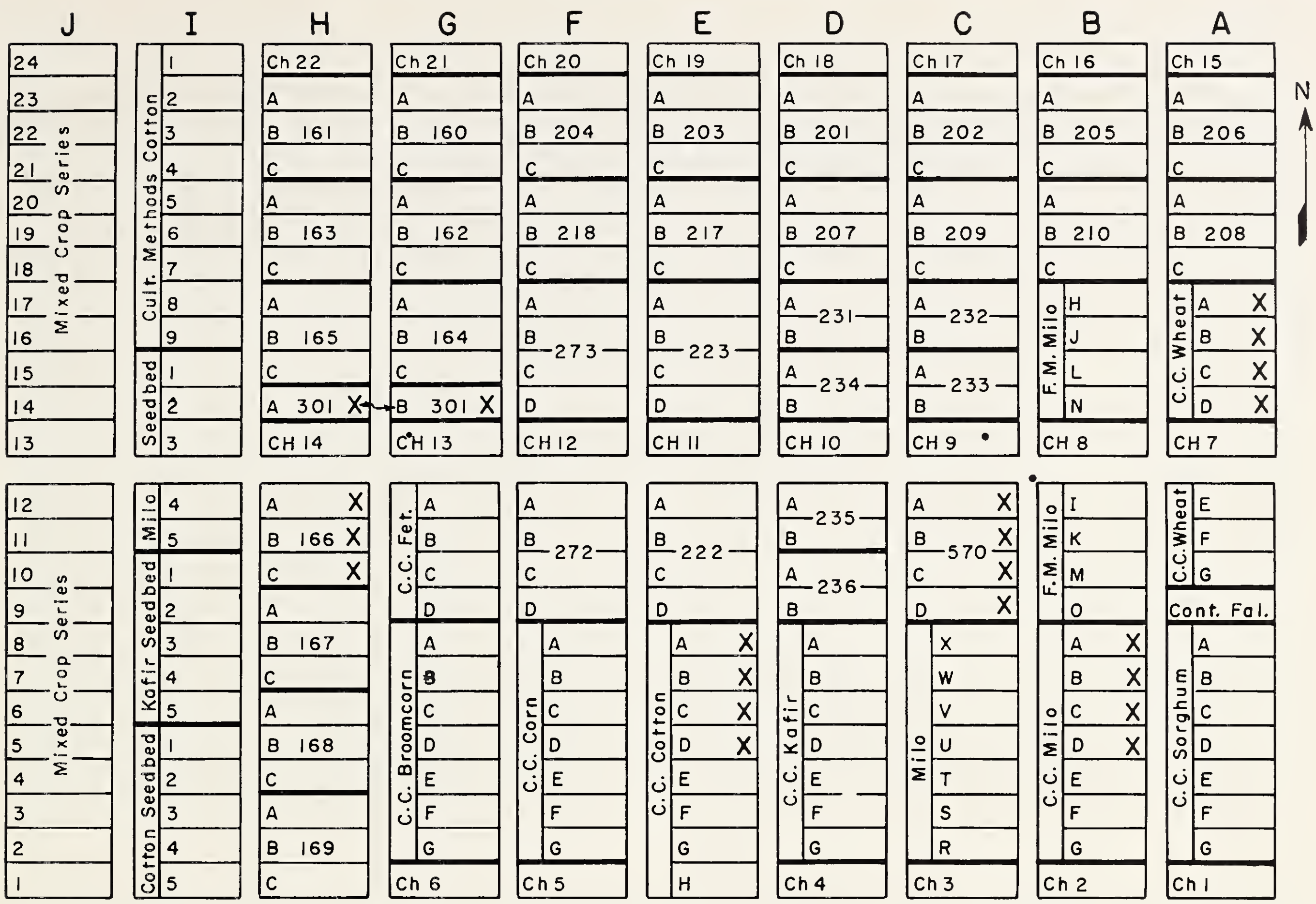
Treatments that were alike as to time of initial tillage operations were performed on the same day insofar as possible. All plots of a given crop were seeded to the same variety on the same date and by the same planting method, except where a difference in planting method was part of the experiment.

Varieties of crops were not changed frequently, but were changed when it appeared desirable. The varieties used in the different years are given in table 4.

The first crop was grown on uniformly prepared land in 1915. The 1916 crop was the first grown under the planned sequence and tillage treatments. Many of the tillage tests were carried on without change during the entire period 1916–53. A number of the rotations and tillage tests were started at later dates. Some were discontinued and replaced by more timely studies.

YIELDS AND RELATIVE ADAPTATION OF CROPS

Average yields of all plots of each of the principal crops grown in the rotations and tillage trials are given (table 5). Averages include results from good, bad, and intermediate methods and are a good indication of the levels of production that can be achieved. Annual results indicate the relative dependability of the different crops.



Cross (X) indicates plots sampled for carbon and nitrogen analyses in 1947.

FIGURE 3.—Crop rotation field at the Big Spring, Tex., Field Station.

TABLE 3.—*Crops included in tillage groups and rotations, and treatments used on the various experimental plots*

CONTINUOUSLY OR ALTERNATELY CROPPED

Crops	Treatment	Plot designation	Tillage group or rotation number
Milo, corn, kafir, sorgo, broomcorn, cotton, feterita	Spring-plowed	A	C. C.
Do	Fall-plowed	B	C. C.
Do	Alternately cropped and fallowed	C or D	C. C.
Milo, corn, kafir, sorgo, broomcorn, cotton	Fall-plowed and subsoiled	E	C. C.
Milo, corn, kafir, sorgo, broomcorn	Spring-listed	F	C. C.
Do	Disked and spring-listed	G	C. C.
Cotton	Fall-listed	F	C. C.
Do	Spring-listed	G	C. C.
Do	Fall-plowed	H	C. C.
Milo, kafir, cotton	Seedbed methods	1–5	Seedbed
Cotton	Cultivation methods	1–9	C. M.
Milo	Alternately cropped and fallowed	H to O	F. M.
Do	Listing methods	R–X	L. M.

2-YEAR ROTATIONS

Crops	Treatment	Plot designation	Tillage group or rotation number
Cotton, cowpeas	Fall-plowed for both crops	A, B	231
Cotton, milo	do	A, B	232
Cotton, peanuts	do	A, B	233
Cowpeas, peanuts	do	A, B	234
Milo, peanuts	do	A, B	235
Milo, cowpeas	do	A, B	236
Do	Spring-plowed for both crops, milo topdressed with manure	A, B	301

Table 3.—*Crops included in tillage groups and rotations, and treatments used on the various experimental plots*—Continued

3-YEAR ROTATIONS

Crops	Treatment	Plot designation	Tillage group or rotation number
Kafir, kafir, cowpeas	Spring-plowed for all crops	A, B, C	160
Milo, kafir, cowpeas	Fall-plowed for all crops	A, B, C	161
Do	Spring-plowed for all crops	A, B, C	162
Kafir, milo, cowpeas	Fall-plowed for all crops	A, B, C	163
Winter wheat, winter wheat, cowpeas	Fall-plowed for second crop of wheat and spring-plowed for cowpeas.	A, B, C	164
Milo, kafir, fallow	Spring-plowed for kafir	A, B, C	165
Winter wheat, milo, cowpeas	Spring-plowed for milo and cowpeas	A, B, C	166
Winter wheat, kafir, cowpeas	Spring-plowed for kafir and cowpeas	A, B, C	167
Kafir, milo, fallow	Spring-plowed for milo	A, B, C	168
Kafir, milo, cowpeas	Spring-plowed for all crops	A, B, C	169
Cotton, cowpeas, milo	Fall-plowed for all crops	A, B, C	201
Do	Spring-plowed for all crops	A, B, C	202
Milo, cowpeas, cotton	do	A, B, C	203
Do	Fall-listed for all crops	A, B, C	204
Cotton, cowpeas, milo	Spring-plowed for cotton and cowpeas; cowpeas turned under	A, B, C	205
Cotton, fallow, milo	Spring-plowed for cotton	A, B, C	206
Milo, cowpeas, corn	Fall-listed for milo and cowpeas; cowpeas turned under	A, B, C	207
Milo, Sudan grass, peanuts	Fall-plowed for all crops	A, B, C	208
Corn, peanuts, Sudan grass	Fall-listed for all crops	A, B, C	209
Corn, peanuts, pinto beans	Fall-plowed for all crops	A, B, C	210
Millet, cowpeas, sorgo	Spring-plowed for all crops	A, B, C	217
Do	Fall-plowed for all crops	A, B, C	218

4-YEAR ROTATIONS

Crops	Treatment	Plot designation	Tillage group or rotation number
Milo, fallow, cotton, cowpeas	Spring-plowed for milo and cowpeas	A, B, C, D	222
Cotton, fallow, milo, cowpeas	Spring-plowed for cotton and cowpeas	A, B, C, D	223
Milo, fallow, cotton, cowpeas	Spring-plowed for milo and cowpeas; fallow manured before plowing.	A, B, C, D	272
Cotton, fallow, milo, cowpeas	Spring-plowed for cotton and cowpeas; fallow manured before plowing.	A, B, C, D	273
Milo, fallow, fallow, fallow		A, B, C, D	570

Cotton and the sorghums were the most productive and reliable crops. Complete failures were rare, and low annual yields were uncommon. In only one year, 1952, were conditions during the growing season so adverse that they caused a failure of all crops.

Cotton is first in importance because the net income per acre received from it is greater than for any other crop grown in this area. It is very drought resistant, and its deep root system helps it to produce some yield under adverse soil moisture conditions. It lends itself well to a crop rotation system, and the plant does not produce a vegetal growth of such size (fig. 4) that an excessive amount of soil moisture is required to produce an average crop. Cotton will probably continue to be the main crop in any rotation or cropping system developed for the area. A cash market is available whenever it is ready for sale.

Grain sorghums, of which there are a number of varieties adapted to this area, are second only to cotton. Until recent years grain sorghums were produced mainly for livestock feed, and when a crop exceeded local livestock requirements, the market value generally dropped.

Recent research has developed many new products from sorghums. As a result, a commercial concern has recently completed a large factory in Texas that is being used exclusively for processing grain sorghums into a number of products. This has developed a new demand for the crop and should help stabilize the market for it.

Plant breeders have developed a large number of new varieties, most of which are of the combine type (fig. 5). These new types, together with the modern combine harvester, have transformed the production of grain sorghums into a mechanized operation that has greatly reduced the cost of production. Combine kafirs and milos have largely replaced the Dwarf Yellow milo and Reed kafir (fig. 6) used in the past. In general the milos outyield the kafirs by a small margin.

Either milo or kafir should have a place in any sound cropping system for this area. Both crops can be used to good advantage as the grain portion of livestock rations. Livestock feeding research (*1*, *2*) has proved that grain sorghums are valuable for fattening beef cattle. Grain sorghums can also be used efficiently in fattening rations for lambs and hogs.

Feterita, until recent years, was considered one of the most drought-resistant sorghums for the area and was grown extensively for "bundle feed."[3] In recent years it has been almost entirely replaced by hegari, a crop that produces a more palatable forage.

Forage sorghums (sorgos) are very dependable. The average yields and the quality of forage produced was highly satisfactory. Sorgos produced more forage per acre than any of the other crops. This forage can be stored as ensilage or as air-cured fodder, both of which are desirable roughages for livestock.

[3] Harvested bundles fed without threshing.

FIGURE 4.—Typical growth of dryland cotton on the high plains of Texas. (Courtesy of the Lubbock substation.)

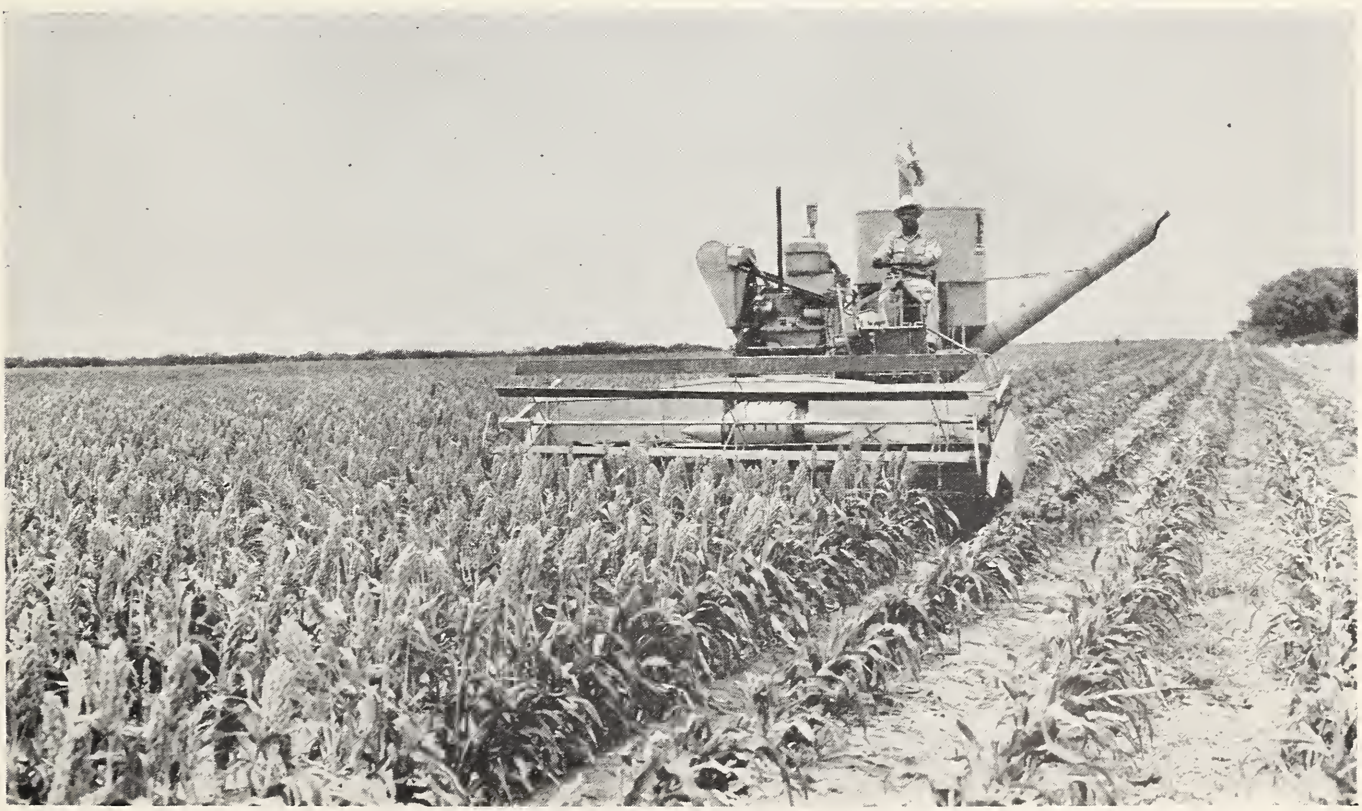


FIGURE 5.—Harvesting a combine-type grain sorghum.

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TABLE 4.—*Varieties of the different crops grown in the rotation and tillage experiments, Big Spring, Tex., 1916–53*

Crop	Variety	Years grown
Milo	Dwarf Yellow	1916–50.
	Midland	1951–53.
Kafir	Dwarf	1916–21.
	Dawn	1922–24.
	Reed	1925–53.
Sorgo	Sumac	1916–53.
Cotton	Mebane	1916, 1919–42.
	Native Mebane	1943–53.
	Trice	1917.
	Lone Star	1918.
Peanuts	Spanish	1916–32, 1949–53.
	Mac Span	1933–49.
Millet	German	1916, 1931–53.
	Kursk	1917–23, 1925–30.
	Hungarian	1924.
Pinto beans	Pinto	1916–53.
Soybeans	Laredo	1929–47.
Cowpeas	Whippoorwill	1916–30.
	New Era	1931–53.
Winter wheat	Turkey Red	1916–21.
	Kanred	1923–30, 1932–38.
	Denton	1931.
	Cheyenne	1939–46.
	Wichita	1947–53.
Feterita	Common	1916–27, 1929.
Broomcorn	Spur	1928, 1932–53.
	Standard	1931.
	Dwarf	1916–21, 1922–25, 1929.
Sudan grass	Scarborough	1926–28, 1930–53.
	Common	1916–44, 1947, 1950–53.
	Sweet Sudan	1945–46, 1948–49.
Corn	Mexican June	1916–36.
	Golden June	1937, 1942, 1944, 1946.
	Yellow June	1938–41, 1943, 1945.
	Texas Hybrid #8	1947–48.
	Hybrid #18	1949–53.

Sudan grass is a valuable crop for this section, although yields of dry forage were much lower than those of the sorgos. Its greatest value is for summer pasture. Few farmers have native grass pastures, and Sudan grass provides the only green forage available on most farms during the summer.

The worth of sorghums in a cropping system is enhanced by their value for erosion protection. Their residues, if properly handled, can be used to eliminate much of the damage from soil movement by wind. The stubble of such varieties as Sudan grass and the forage sorghums, when planted closely in the row, prevents damaging blowing if not harvested too closely. Grain sorghums cut to the same height as varieties spaced closer in the row do not provide the same degree of protection. If cut high, however, the stalks either left standing or leveled with a stalk cutter are also effective. In years when drought during the normal growing season has made supplies of surface residues scanty, sorghums are sometimes seeded after late rains with a grain drill and the entire immature crop left on the land over winter.

Cowpeas have produced fair yields of hay and seed in trials at the Big Spring station. They are one of the few annual legumes adapted to the area, and produce a good quality of high protein hay.

TABLE 5.—*Average annual acre yields of crops in rotation field, Big Spring, Tex., 1916–53*

Year	Acre yields of—												
	Milo	Kafir	Feterita	Corn	Wheat	Beans	Cotton (seed cotton)	Broom-corn brush	Peanuts	Sorgo, total weight	Sudan grass	Cowpea hay	Millet hay
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1916	24.9	19.6	12.7	9.1	3.1	5.8	225	354	685	9,868	6,160	2,278	2,390
1917	8.3	1.0	2.3	.7	7.9	1.3	47	114	68	1,205	310	168	0
1918	2.2	0	0	0	0	0	194	67	167	3,393	1,540	880	0
1919	50.1	33.4	34.0	16.0	8.3	0	1,178	584	1,483	12,548	10,340	1,636	3,860
1920	29.9	28.3	19.0	16.6	16.7	7.5	1,362	466	1,485	12,608	9,160	3,122	3,120
1921	21.5	16.3	12.7	3.4	3.9	0	488	268	115	5,423	3,880	2,194	2,145
1922	25.2	18.2	20.1	6.2	0	0	597	432	0	7,043	4,020	1,988	1,565
1923	30.9	16.2	14.3	9.0	2.1	0	965	308	0	5,695	3,990	1,592	1,250
1924	6.9	7.0	5.7	1.0	3.9	0	504	168	90	3,710	2,610	97	0
1925	15.6	15.6	8.0	5.2	0	0	777	223	1,198	5,800	5,110	734	540
1926	19.2	23.9	23.6	12.2	9.0	0	695	462	1,177	9,228	6,150	1,361	1,050
1927	17.3	12.4	13.1	1.6	1.6	0	515	253	727	5,465	2,355	972	0
1928	27.9	24.0	18.0	14.0	2.8	1.3	980	407	872	8,188	3,770	1,094	0
1929	13.6	9.9	8.2	1.7	1.4	4.7	515	300	713	6,641	2,730	1,204	2,120
1930	9.2	8.2	7.2	2.6	1.6	0	488	198	152	3,948	1,780	780	0
1931	22.4	20.4	17.0	6.3	3.0	0	641	252	475	6,311	2,550	1,544	1,050
1932	25.2	28.0	16.7	9.2	27.0	0	829	328	1,128	8,960	6,200	1,392	2,550
1933	21.3	15.4	19.7	8.3	8.7	5.7	596	0	540	6,246	3,705	657	1,170
1934	17.9	13.0	16.9	.8	7.9	2.7	570	188	205	3,940	1,660	641	645
1935	23.3	14.1	33.6	7.9	1.9	6.7	1,108	357	840	6,632	3,790	1,211	2,700
1936	8.2	7.2	6.2	1.2	1.1	0	341	112	265	3,250	1,870	892	1,190
1937	20.2	16.3	22.1	3.0	6.7	2.3	1,000	153	503	3,588	2,230	1,044	600
1938	31.0	28.1	31.3	1.3	0	0	781	523	133	7,600	3,750	3,623	2,500
1939	23.7	20.4	18.1	3.7	1.1	.8	818	317	158	4,270	1,740	1,800	2,000
1940	21.0	14.3	7.0	9.5	0	5.8	886	293	318	4,894	2,000	1,386	1,240
1941	42.6	34.4	22.9	14.2	19.9	1.0	1,179	380	1,623	10,235	6,650	3,186	4,300
1942	25.6	16.6	17.8	4.9	8.1	3.3	515	190	975	5,299	4,400	1,112	850
1943	20.9	17.2	0	13.5	4.5	0	632	315	197	4,736	4,390	2,272	2,100
1944	17.2	11.5	9.2	1.9	.8	0	804	235	477	7,033	1,900	1,459	1,650
1945	34.6	28.9	27.5	2.1	4.1	0	727	180	775	8,635	3,350	2,848	2,900
1946	14.2	11.0	8.2	0	3.2	0	399	72	683	2,350	2,590	616	650
1947	14.2	9.3	5.9	11.4	4.4	1.6	683	235	113	3,691	1,400	1,407	1,350
1948	12.2	9.6	6.8	1.6	2.2	0	368	255	0	3,950	950	1,367	1,150
1949	16.1	10.8	5.6	8.2	4.8	0	705	142	0	2,096	2,100	1,031	700
1950	25.3	18.9	15.1	3.5	4.4	3.3	918	307	372	4,346	3,250	2,538	3,850
1951	6.1	5.5	3.1	1.1	0	0	419	150	0	1,988	520	664	550
1952	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	1.8	0	3.4	0	0	0	186	0	73	1,531	560	0	0
Average	19.7	15.4	13.5	5.6	4.6	1.4	648	252	494	5,588	3,302	1,389	1,414

FIGURE 6.—Reed kafir on the experimental plots. This variety, once widely grown, has been largely replaced by varieties adapted to harvesting with a combine.

However, land from which cowpea hay has been harvested is susceptible to soil blowing (fig. 7) and requires preventive cultivation. Cowpeas never have been and probably never will be very popular as a hay crop. They have been grown to a small extent as a green-manure crop for soil improvement.

Corn is not adapted to this area, and its average yields (table 5) showed that it was not a profitable crop. Only in years of exceptionally favorable soil moisture does it produce yields that might justify its use. In less favorable years sorghums are much more productive.

Winter wheat has produced grain yields too low to justify its use for grain production alone. Many livestock farmers seed wheat regularly for the purpose of producing winter and early-spring grazing. If soil moisture conditions are favorable a grain crop may be harvested. In years of ample rainfall this combination use makes a wheat crop well worth while.

Pinto beans have no place as a crop in this area. They do not usually set seed except when planted in late July or early August, so that they reach the pollination stage after the hot summer period. The weather during their rapid growth period is generally too dry to permit development of a worthwhile crop.

Broomcorn is rather drought resistant and normally produces fair yields of brush. In general, it cannot compete with cotton as a cash crop, and facilities for handling it have never been developed for this part of the State.

Peanuts are well adapted to sandy land and usually produce profitable yields. One of the chief objections to growing peanuts is the condition in which the soil is left after harvest. Crop residue is absent in the fall, and this condition permits soil blowing that may be difficult to control when wind velocities are high.

Millet is a short-season annual grass with yields too low to justify its regular use in this area. Average hay yields were about equal to those of cowpeas, but the quality of hay was much poorer and failures or low yields more frequent.

RESULTS FROM TILLAGE PRACTICES

Tillage practices were tested chiefly on land planted annually to the same crop, or alternately fallowed and planted to that crop. In this presentation similar tillage treatments with different crops are grouped when possible so that their effect can be compared.

Continuous Cropping Experiments With Row Crops

Substantially the same tillage treatments were carried on for many years with five types of sorghum and with corn and cotton. These are the plots referred to as C. C. (continuous cropping) in table 3.

Timing of field operations was much the same for the different crops. During the first 18 years (1916–33) the average date of spring plowing was May 9; during the period 1934–53 it was advanced to April 2. Fall plowing was done when crop removal and soil conditions permitted, usually in early December, although the dates ranged from October to after the first of the year. Subsoiling was done at the same time as fall plowing. The subsoiler was run to an additional depth of 8 to 10 inches in each furrow. During most of the time it was done in 2 consecutive years and then omitted for a like number of years.

All sorghums were planted at approximately the same date, which averaged about June 1. Corn was planted a few days earlier than sorghums, and cotton a few days earlier than corn.

Results from the continuous cropping tillage experiment are given in table 6. They show that with a few exceptions the different crops reacted to tillage variables in much the same manner.

Every crop produced materially higher yields on fall-plowed than on spring-plowed land. Every crop produced its lowest yield when planted with a lister without previous tillage. A single surface tillage operation in the early spring greatly increased production on lister-planted land. All crops except cotton and corn produced higher yields on fallowed than on cropped land, but in no case was the increase over annual cropping enough to compensate for the loss of a crop.

All crops except milo produced higher yields on plowed and subsoiled than on plowed land, but with the possible exception of cotton the increase would not have paid the cost of subsoiling.

FIGURE 7.—Harvesting a good crop of cowpea hay. Two rows are cut just below the soil surface and thrown into a windrow. After the hay is removed there is no residue left for soil protection.

TABLE 6.—*Yields of 7 row crops on land annually cropped by the same method, or alternately fallowed and cropped, Big Spring, Tex., 1916–53*

Treatment	Average acre yield of—									
	Milo grain	Feterita grain	Kafir		Broomcorn		Sorgo, total weight	Corn		Cotton (seed cotton)
			Grain	Stover	Brush	Stover		Grain	Stover	
	Bushels	*Bushels*	*Bushels*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Bushels*	*Pounds*	*Pounds*
Annual cropping:										
Spring-plowed	16.4	9.6	13.5	1,973	204	1,955	4,833	3.8	1,085	479
Fall-plowed	19.9	12.6	15.8	2,302	273	2,534	5,648	6.3	1,373	655
Fall-plowed and subsoiled	19.3		17.3	2,534	284	2,718	5,818	8.2	1,496	813
Lister-planted without prior cultivation	7.4		11.6	1,801	191	1,848	2,881	3.4	916	615
Lister-planted with prior spring cultivation	13.8		16.2	2,280	234	2,329	5,000	4.8	1,234	
Fall-plowed, lister-planted										828
Fall-listed, lister-planted										756
Alternately fallowed and cropped	26.4	18.2	20.2	3,091	327	3,137	7,930	8.1	1,502	795

That lister planting in itself is not unfavorable to crop production is brought out by the two plots of cotton that were fall-tilled and lister-planted. The fall-plowed lister-planted plot produced the highest average cotton yield.

Differences in relative yields on fall- and spring-plowed land associated with the change in time of spring plowing are demonstrated by the data shown in table 7. In every case the difference in favor of fall plowing was greatly reduced, but the difference was not entirely eliminated during the period that spring plowing was done early.

Annual yields of most of the crops are given in appendix, tables 26 and 27.

Listing Methods With Milo

This experiment was planned to determine the relative yields from different methods of preparing land to be planted with a lister. Middlebreakers or disks were used for the leveling operations. Harrowing was done with a spike-tooth harrow that killed small weeds on the ridges without throwing much of the soil into the furrows.

All methods of preparation where cultivation was started in the fall and where some type of cultivation was given in the spring were approximately equal in yield (table 8). The fall-listed plot not given spring cultivation was a little lower

TABLE 7.—*Difference between fall plowing and spring plowing for 7 row crops during 2 periods of years, Big Spring, Tex., 1916–53*

Period	Average date of spring plowing	Difference in favor of fall plowing for—									
		Milo grain	Feterita grain	Kafir		Broomcorn		Sorgo, total weight	Corn		Cotton (seed cotton)
				Grain	Stover	Brush	Stover		Grain	Stover	
		Bushels	*Bushels*	*Bushels*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Bushels*	*Pounds*	*Pounds*
1916–33	May 9	6.3	6.0	3.2	560	131	993	1,702	4.5	545	281
1934–53	Apr. 2	1.1	.3	1.6	122	14	205	17	.7	56	81

in yield, owing to weed growth before planting. Plots listed in the spring were less productive than those where cultivation was started in the fall. The lowest yield resulted from spring listing and splitting the ridges at planting.

Taking into account costs, weed control, and erosion control, the practice considered best is late-fall or early-winter listing, knife cultivation in the spring to control weeds until planting time, and planting with a lister by splitting the ridges.

TABLE 8.—*Average acre yields of lister-planted milo on land given different tillage treatments prior to planting, Big Spring, Tex., 1916–53*

Land preparation and seeding method	Acre yields
	Bushels
Fall-disked, winter-listed, spring-leveled, lister-planted in same furrows	19.4
Fall-listed, winter-leveled, lister-planted in same furrows	18.7
Fall-listed, spring-leveled, lister-planted in same furrows	18.9
Fall-listed, spring-harrowed, lister-planted by splitting ridges	19.1
Fall-listed, lister-planted by splitting ridges	17.8
Spring-listed, lister-planted in same furrows	16.8
Spring-listed, lister-planted by splitting ridges	15.5

Methods of Cultivation for Cotton

The main portion of this experiment consisted of 3 pairs of plots given different methods of initial spring tillage. The 2 plots in each pair were planted by different methods.

Listing was more productive than either disking or plowing (table 9). There was no appreciable difference between the 2 planting methods. Plowing and disking were nearly equal. The average difference in favor of planting with furrow openers over surface planting was about 50 pounds to the acre.

TABLE 9.—*Acre yields of seed cotton on land prepared and planted by different methods, Big Spring, Tex., 1924–48*

Land preparation and seeding method	Acre yields, seed cotton
	Pounds
Spring-listed, lister-planted in same furrow	543
Spring-listed, lister-planted by splitting ridges	538
Spring-disked, planted with surface planter	387
Spring-disked, planted with furrow openers	439
Spring-plowed, planted with surface planter	399
Spring-plowed, planted with furrow openers	445

This same experiment contained 3 plots with the same cultivation prior to planting and the same treatment, but with differences in tillage after planting. A plot cultivated only twice produced a higher yield than one cultivated 6 times or one not cultivated at all but kept free from weeds by hoeing.

Seedbed Preparation for Milo, Kafir, and Cotton

The somewhat contradictory results for milo and cotton made it seem desirable to start an experiment with what were considered to be the 3 principal crops. This experiment was set up to answer 2 questions: (1) Would listing in January prove superior to listing in late March or early April? and (2) Is leveling and planting in the same furrows superior to splitting the ridges at planting? The initial tillage operation and the planting were both done with a lister. A fifth plot, winter-plowed and planted with furrow openers, was included for comparison.

TABLE 10.—*Yields of milo, kafir, and cotton on seedbeds prepared by 5 different methods, Big Spring, Tex., 1926–48*

Tillage method [1]	Acre yields of—			
	Milo grain	Kafir		Cotton (seed cotton)
		Grain	Stover	
	Bushels	*Bushels*	*Pounds*	*Pounds*
Winter-listed, planted in same furrows	18.4	14.8	2,183	590
Winter-listed, ridges split in planting	17.9	16.8	2,286	614
Spring-listed, planted in same furrows	16.7	18.3	2,130	537
Spring-listed, ridges split in planting	12.6	17.0	2,011	599
Winter-plowed, planted with furrow openers	16.6	20.0	2,288	730

[1] Winter listing and plowing on average date of January 22; spring listing on average date of April 2.

Results from different methods of seedbed preparation for the three crops were not the same (table 10). Milo appeared to benefit somewhat from the winter listing, and to be more productive

when planted in the same furrows. Cotton appeared to benefit very slightly from winter tillage, but, in contrast to milo, produced slightly higher yields when the ridges were split than when planted in lister furrows. Kafir did not appear to benefit from winter cultivation. The highest yields of both kafir and cotton were produced on land that was plowed in winter and the crop planted with furrow openers. The results with any individual crop do not appear to contradict those obtained in the other tillage experiments (tables 6, 8, and 9).

Methods of Fallowing for Milo

Four widely different methods of fallow tillage for milo were under trial for the whole period (1916–53). The methods and the average yields resulting from their use are given in table 11.

Table 11.—*Acre yields of milo on land prepared by different methods of fallow tillage, Big Spring, Tex., 1916–53*

Land preparation	Acre yields, milo grain
	Bushels
Plowed after milo harvest, replowed in June	28.8
Plowed after milo harvest	29.9
Plowed in early spring	26.0
Plowed in June	25.3

The 2 plots plowed after milo harvest produced an average yield of nearly 4 bushels to the acre above that on spring plowing. No benefit was derived from replowing. Plowing in the early spring was little better than delaying the operation until June. The reason for the better yields when land to be fallowed is plowed in the fall was not evident. It could hardly be caused chiefly by difference in moisture storage, since the period between spring plowing for fallow and planting (about a year) would seem sufficient to enable the soil to accumulate most of the moisture it was capable of holding.

The yield from early spring-plowed fallow (26.0 bushels to the acre), is almost identical with that (26.4 bushels to the acre) obtained from the same method of fallowing in the continuous cropping experiment (table 6). Thus, the method of fallow used in the continuous cropping experiments was not the most productive one that could have been used. Even the most productive method of fallowing would not have made the practice as profitable as the better methods of annual cropping. The fall-plowed methods with fallowing entail a serious soil-blowing hazard. The period between fall plowing and the seeding of the next crop is 18 months, altogether too long a time for land to be under fallow cultivation.

A 4-year rotation (570) consisting of 3 years of fallow and 1 of milo is located adjacent to the crop rotation field (fig. 3) and can be properly compared to the different methods of 1-year fallow. The purpose of rotation 570 was to determine the behavior of milo on land that held at seeding time the maximum quantity of water that it could hold under the prevailing climatic conditions. Its average yield, 29.2 bushels to the acre, was no higher than on fall-plowed 1-year fallow.

Continuous Cropping Methods for Winter Wheat

Winter wheat is relatively unproductive, as shown in table 5. It is grown chiefly for winter and early-spring pasture, but may be left for harvest when spring moisture conditions are unusually favorable. The infrequency with which this occurs is demonstrated by the fact that the average yield of winter wheat in these experiments exceeded 10 bushels to the acre only 3 times in 38 years.

There were some small yield differences due to tillage methods. A plot where plowing was done shortly before seeding produced an average yield of 3.5 bushels to the acre; a plot plowed shortly after wheat harvest produced 4.8 bushels; a subsoiled plot produced 5.2 bushels; and a plot on fallowed land 5.0 bushels to the acre. Detailed annual yields for these plots are given (appendix, table 26). There were 2 listed plots in the experiment, but the time of their initial cultivation varied so much that their average yield cannot be directly compared to average yields from other methods. Comparisons for shorter periods show, however, that yields on listed land are equal to yields on land plowed on the same date.

RESULTS FROM CROP ROTATIONS

Rotation experiments were planned principally to test the effects of different crops on each other and on the soil, although many of the rotation experiments contained some tillage variables. They have been studied ever since the work of the station was started. Their usefulness has been severely limited by the absence of perennial legumes or grasses adapted to use in short rotations. Nearly all the crops suited to the area are grown in cultivated rows. The only practices concerned chiefly with soil maintenance were plowing under green-manure crops and applying stable manure.

Rotations are divided into general groups that are more comparable within than between groups. Their locations in the field (fig. 3) also make it desirable to discuss the different groups as units.

TABLE 12.—*Effect of previous crop and method of tillage in a group of ten 3-year rotations, Big Spring, Tex., 1919–48*

Rotation No.	Crop sequence	Tillage method	Milo grain	Kafir		Cowpea hay	Winter wheat grain
				Grain	Stover		
			Bushels	*Bushels*	*Pounds*	*Pounds*	*Bushels*
161	Milo, kafir, cowpeas	Fall-plowed	27.0	19.5	2,361	1,635	
162	do	Spring-plowed	18.6	14.6	2,174	1,221	
163	Kafir, milo, cowpeas	Fall-plowed	19.8	19.9	2,680	1,559	
[1] 169	do	Spring-plowed	22.4	19.6	2,650	1,633	
160	Kafir, kafir, cowpeas	Spring-plowed		17.2	2,378	1,365	
				[2] 16.5	[2] 2,182		
165	Milo, kafir, fallow	Spring-plowed for kafir	24.8	14.5	2,116		
[1] 168	Kafir, milo, fallow	Spring-plowed for milo	24.9	22.2	2,802		
166	Wheat, milo, cowpeas	Spring-plowed for milo and cowpeas	13.8			1,332	5.5
[1] 167	Wheat, kafir, cowpeas	Spring-plowed for kafir and cowpeas		14.7	2,298	1,495	7.1
164	Wheat, wheat, cowpeas	Spring-plowed for cowpeas				1,089	3.7
		Fall-plowed for wheat after wheat					[3] 5.1

[1] Rotations 168 and 169 are in a favorable location and yields are higher than can be ascribed to the sequence or method of tillage. Rotation 167 was also benefited by location, but not to the same extent as the others.
[2] Yield of kafir following kafir.
[3] Yield of wheat following wheat.

Group 1. Three-Year Rotations

The 3-year rotations (Nos. 160 to 169) were started at several field stations in the southern Great Plains. The purpose of the rotations was to determine whether or not tillage should begin in the fall and to determine the order in which crops should be grown. No soil-improving crops or practices were incorporated into the rotations. They consisted generally of 2 major sorghum crops and 1 legume hay crop (table 3). In some rotations fallow or winter wheat replaced 1 or more of the other crops. Part of this group of rotations was discontinued after 1948 at Big Spring, so the comparisons are confined to the 1919–48 period (table 12).

All crops were more productive on fall than on spring plowing, except where yields were influenced by location (footnote 1, table 12). Kafir did better after cowpeas than after milo on both fall and spring plowing. The difference was most evident in the yields of stover. Milo produced its highest yield on fall-plowed cowpeas. Crops on wheat stubble not plowed until spring produced relatively low yields. Where the stubble was plowed shortly after wheat harvest (rotation 164) the yield on winter wheatland was higher than the yield after cowpeas in the same rotation.

Yields on fallowed land are not increased enough to justify the use of fallow in the cropping system.

Group 2. Three-Year Sorghum-Cotton Rotations

This group of 3-year rotations (Nos. 201 to 206) centered around cotton, milo, and cowpeas. Average results are given in table 13.

Differences due to sequences were small. Yields of both milo and cotton were slightly higher following cowpeas than following each other. Yields of cowpeas following milo were about equal to those following cotton.

TABLE 13.—*Effect of previous crop and method of tillage in a group of six 3-year rotations, Big Spring, Tex., 1916–53*

Rotation No.	Crop sequence	Tillage method	Acre yields of—		
			Cotton (seed cotton)	Milo grain	Cowpea hay
			Pounds	*Bushels*	*Pounds*
201	Cotton, cowpeas, milo.	Fall-plowed	649	21.6	1,437
202	do	Spring-plowed	499	18.6	1,328
203	Milo, cowpeas, cotton.	do	580	17.1	1,324
204	do	Fall-listed	679	20.5	1,450
205	Cotton, cowpeas plowed under, milo.	Spring-plowed for cotton and cowpeas.	591	23.7	
206	Cotton, fallow, milo	Spring-plowed for cotton.	612	27.4	

The major differences shown were the result of tillage methods used. In every case the yield on fall-plowed or fall-listed land was noticeably better than on spring plowing. Plowing under a crop of cowpeas produced a yield of milo only 2.1 bushels higher than after cowpeas harvested for hay. This small gain did not compensate for the loss of more than 1,400 pounds of cowpea hay.

Fallowing increased the yield of milo, but, as in other experiments, the increase was not enough to compensate for the loss of a year's crop.

Group 3. Three-Year Rotations That Include Minor Crops

Rotations 207 to 210 afforded few direct comparisons. They were designed chiefly to determine the annual production of some crops not

TABLE 14.—*Yields of crops in four 3-year rotations, Big Spring, Tex., 1916–53*

Rotation No.	Crop sequence	Tillage method	Acre yields of— Milo grain	Pinto bean seed	Corn: Grain	Corn: Stover	Peanuts: Nuts	Peanuts: Hay	Sudan grass hay
			Bushels	*Bushels*	*Bushels*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
207	Milo, cowpeas plowed under, corn	Fall-listed for milo and cowpeas	20.4		5.0	1,505			
209	Corn, peanuts, Sudan grass	Fall-listed			3.5	1,294	463	1,876	[1] 2,958
210	Corn, peanuts, pinto beans	Fall-plowed		1.5	7.4	1,847	526	1,849	
208	Milo, Sudan grass, peanuts	Fall-plowed	15.1				395	1,648	3,258

[1] Sudan grass was substituted for pinto beans in 1923 and has been used since then.

considered to be of major importance and to see how they fit in with other crops. Average results are given in table 14.

Sudan grass was fairly productive, but yields of crops following it were depressed. The Sudan grass was harvested for hay and left the soil exceedingly dry. Had conditions permitted pasturing (the most valuable use of the crop), its effect on crops following might have been different. The yield of corn after pinto beans was better than on other methods, but the bean crop failed so frequently that the land was practically fallow in about half the years. Plowing under a green-manure crop was not effective in improving the yield of corn. Peanut yields were satisfactory but, as explained earlier, their value as a crop is reduced by the soil-blowing hazard they introduce.

Rotations 217 and 218 afford a direct comparison of spring and fall plowing in 3-year feed-crop rotations. As in most other experiments, fall plowing was superior for all crops. Average yields in pounds to the acre of the 3 crops on fall plowing and spring plowing, respectively, were: Cowpea hay, 1,493 and 1,328; millet hay, 1,530 and 1,280; and sorgo fodder, 6,824 and 5,700.

Group 4. Two-Year Rotations With Sequence Variables

This group of rotations (Nos. 231 to 236) was composed of six 2-year rotations that were identical in tillage method and differed in sequence. Average yields are given in table 15.

TABLE 15.—*Effect of sequence on crop yields in six 2-year rotations fall-plowed for all crops, Big Spring, Tex., 1916–53*

Rotation No.	Crop sequence	Acre yields of— Cotton (seed cotton)	Cowpea hay	Peanuts: Nuts	Peanuts: Hay	Milo grain
		Pounds	*Pounds*	*Pounds*	*Pounds*	*Bushels*
231	Cotton, cowpeas	640	1,376			
233	Cotton, peanuts	598		513	1,913	
232	Cotton, milo	512				12.4
236	Milo, cowpeas		1,511			21.9
235	Milo, peanuts			481	1,551	18.3
234	Cowpeas, peanuts		1,390	588	2,105	

All the other crops were more productive following cowpeas than following each other.

Group 5. Four-Year Manured and Unmanured Rotations, and Two-Year Manured Rotation

The four 4-year rotations (Nos. 222, 223, 272, and 273) were set up to determine the effect of manure in rotations, and whether milo or cotton would show most immediate benefit from it.

Rotations 272 and 222 were identical rotations of fallow, cotton, cowpeas, and milo that differed only in that manure was applied to the fallow in rotation 272. Rotations 273 and 223 contained the same crops as rotations 272 and 222, but were arranged in a different order. In these rotations the milo was on fallow and the cotton followed cowpeas. Manure was applied to the fallow in rotation 273. Cowpeas were the second crop after fallow in both sets of rotations.

The annual and average yields from the 4-year rotations are shown in appendix, table 28. On the basis of average yields, applications of manure had little benefit. Only in the case of cotton on fallow was the yield increased enough to pay the cost of applying the manure.

The data were further examined by periods to find whether there were any progressive changes with time in favor of the manured rotation.

Trends in the 4-year rotations were obscured by annual differences due to weather, but the general production trends for the rotations using manure were exactly opposite those without manure (fig. 8). Where the cotton was grown on fallowed land (fig. 8, *A*), yields of all crops in the manured rotation increased in comparison with the unmanured rotation. Where the milo was on fallowed land, all crops on the manured rotation showed a progressive decrease. The cause of this diverse behavior has not been determined. If the 2 manured and the 2 unmanured rotations are averaged (table 16), the net benefits in yields were exceedingly small. This was in spite of the fact that the crop immediately following manure was on fallowed land and had the advantage of more moisture than is available under annual cropping.

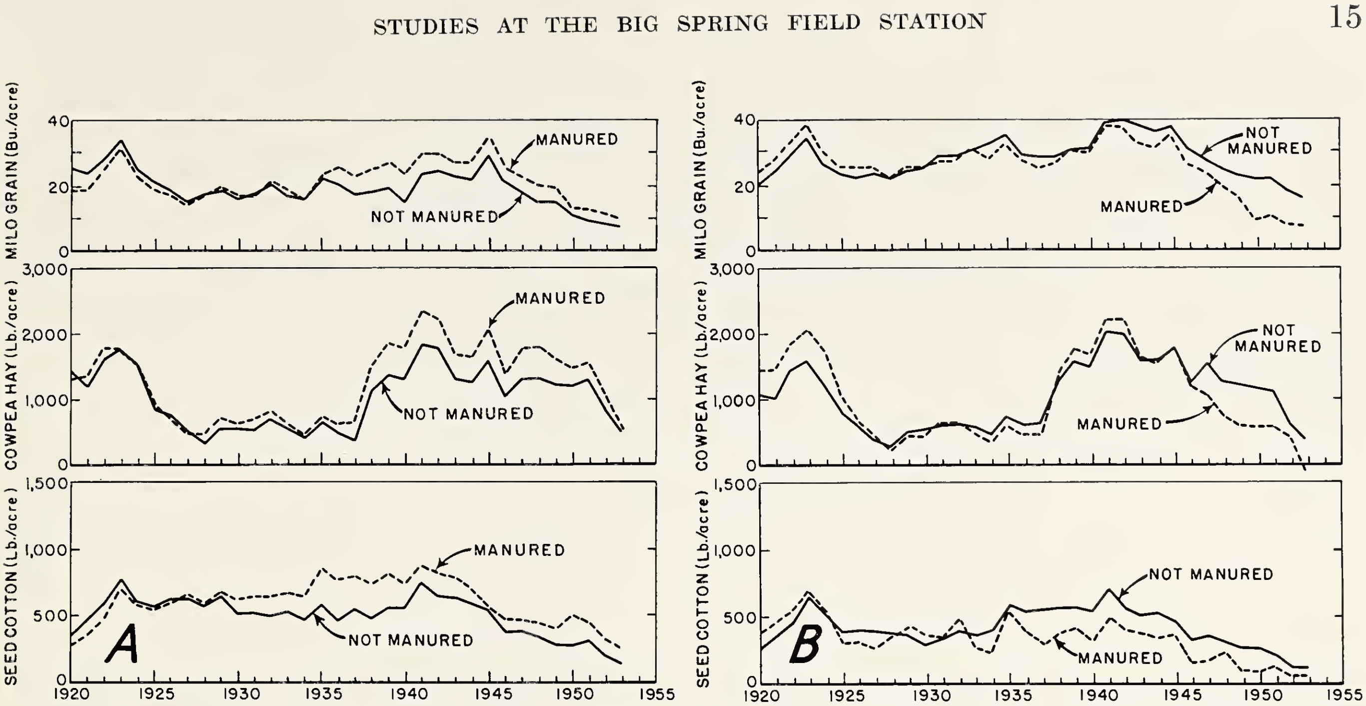

FIGURE 8.—Five-year moving average yields of crops in manured and unmanured 4-year rotations, Big Spring, Tex., 1916–53: *A*, Rotations of fallow, cotton, cowpeas, and milo; and *B*, rotations of fallow, milo, cowpeas, and cotton. (Each point on the chart represents the average yield for the 5 years ending with that year.)

TABLE 16.—*Differences in yield between 2 manured and 2 unmanured rotations by periods, Big Spring, Tex., 1916–51*

Period	Difference in favor of manured rotation		
	Milo [1] grain	Cotton [1] (seed cotton)	Cowpea [2] hay
	Bushels	*Pounds*	*Pounds*
1916–21	−1.7	3	157
1922–27	.5	−39	−8
1928–33	.5	48	45
1934–39	1.7	36	257
1940–45	2.0	−30	252
1946–51	−5.1	7	−179

[1] Average of first and third crops after fallow.
[2] Second crop after fallow.

Manure was also applied in a 2-year rotation (No. 301). This was a spring-plowed sequence of milo and cowpeas. It cannot be compared directly to any of the other rotations, but the yields can be compared roughly to yields under similar tillage and sequence in the 3-year rotations reported in table 11. The average yields of 16.2 bushels for milo and 1,377 pounds for cowpea hay were below those obtained under similar sequences in rotations 162 and 169, respectively.

The data were also compared with those from rotation 236, an unmanured rotation of cowpeas and milo on fall-plowed land (table 15). Yields on rotation 301 were lower, caused chiefly by the normal difference between fall and spring plowing. The data from the two rotations were further compared to see whether their relative yields had changed with time. There was no consistent trend.

Group 6. Mixed-Crop Series

This group of plots was started to find whether the major crops, such as cotton and the sorghums, would be benefited by growing them in pairs of rows alternating with pairs of rows of legumes. It was thought that the stubble from the other crops might afford some protection to the land where a legume crop had been removed, and it was possible that legumes in the rotation might benefit the other crops. Each of the crops was grown alone as well as in paired rows.

The effect of paired rows on the yields of crops grown each year on the same land is shown in table 17. Yields for the paired rows were calculated on the actual area occupied by each of the 2 crops. This was done to bring out the extent to which the yield of 1 crop was affected by growing it with the other. For example, a 2-acre plot of ground, one acre all in cotton and the other acre in peanuts would produce 643 pounds of seed cotton and 559 pounds of peanuts. If the 2 crops were planted in paired rows, the same area would produce 762 pounds of cotton and 437 pounds of peanuts. The yield of cotton was increased 119 pounds and that of peanuts was reduced by 122 pounds by growing the 2 crops in paired rows. Similar comparisons can be made with all of the other combinations of crops.

No evidence occurs that total production on a given area of land is improved materially by growing two crops in paired rows. Wherever the yield of one crop was increased by the association, the yield of the other crop was reduced.

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TABLE 17.—*Yields of crops grown in paired rows and in pure stands, Big Spring, Tex., 1929–47*

Crop or crop combination	Acre yields of—								
	Cotton (seed cotton)	Milo grain	Sorgo, total weight	Cowpea hay	Soybean hay	Kafir		Peanuts	
						Grain	Stover	Nuts	Hay
	Pounds	*Bushels*	*Pounds*	*Pounds*	*Pounds*	*Bushels*	*Pounds*	*Pounds*	*Pounds*
Cotton	643								
Cotton–peanuts	762							437	1,407
Cotton–cowpeas	536			1,897					
Peanuts								559	1,430
Kafir						16.8	1,922		
Kafir–cowpeas				1,611		15.8	2,046		
Sorgo			5,408						
Sorgo–cowpeas			5,575	1,569					
Cowpeas				1,894					
Milo		22.3							
Milo–cowpeas		23.4		1,761					
Milo–soybeans		29.4			989				
Milo–late cowpeas		24.0		2,294					
Milo–peanuts		31.0						482	1,454
Soybeans					1,086				

There is some evidence that land from which nearly all the residue has been removed, such as legume hay land, is less subject to severe soil blowing when partially protected by residues of other crops, such as sorghums. Limitations of space in plot experiments necessitated the use of pairs of rows, but under field conditions strips could be considerably wider. Use of such strips will not stop soil blowing on susceptible land, but they may prevent soil blowing from reaching the proportions it might attain on land without such obstructions.

Ten plots in the group were farmed on an alternate fallow and crop basis. They were used chiefly to determine the response to fallow of some of the legumes, with milo used for comparison. Yields of the crops grown on fallow, together with the yields of the same crops grown continuously, are given in table 18. None of the legume crops was benefited greatly by being grown on fallowed land. Cowpea and soybean yields were increased only slightly, and the yield of peanuts was reduced sharply. Milo showed an even more pronounced benefit from fallow than was evident in other tests (tables 6, 13). Even in this test, 9.6 more bushels to the acre was produced by planting all the land to milo each year than was produced by planting half the land to milo on fallow, and fallowing the other half. The behavior of paired rows of milo and cowpeas was much the same as on continuously cropped land. The differences between growing the 2 crops on separate areas and growing them in paired rows was smaller than the experimental error.

TABLE 18.—*Yields of crops on fallowed land and yields of the same crops on annually cropped land, Big Spring, Tex., 1931–47*

Crop or crop combination	Yields of crops on—							
	Fallowed land				Cropped land			
	Milo grain	Peanuts		Cow-pea or soy-bean hay	Milo grain	Peanuts		Cow-pea or soy-bean hay
		Nuts	Hay			Nuts	Hay	
	Bu.	*Lb.*	*Lb.*	*Lb.*	*Bu.*	*Lb.*	*Lb.*	*Lb.*
Milo	33.0				23.4			
Milo-cowpeas	35.4			2,294	24.4			1,801
Cowpeas				2,206				1,992
Soybeans				1,126				1,093
Peanuts		338	1,245			575	1,437	

RESULTS WITH COMMERCIAL FERTILIZERS

Tests of the effects of commercial fertilizers were carried on from 1948 to 1953 with sorghums, and from 1951 to 1953 with cotton. Climatic conditions were generally unfavorable throughout the period, and differences in yields due to fertilizer treatments had little opportunity to become evident.

TABLE 19.—*Yields of sorghums under different fertilizer treatments, Big Spring, Tex., 1948–50*

Fertilizer treatment per acre	Acre yields of—		
	Early hegari, total weight [1]	Caprock milo, grain	
	1948	1949	1950
	Pounds	*Pounds*	*Pounds*
Check (no fertilizer)	5,669	889	1,360
60 pounds P_2O_5 at planting	5,448	676	1,569
60 pounds P_2O_5 and 20 pounds N at planting	4,990	756	1,622
20 pounds N at planting	5,250	756	1,387
60 pounds P_2O_5 at planting, 20 pounds N 4 to 6 weeks later	5,189	882	1,471
60 pounds P_2O_5 at planting, 40 pounds N 4 to 6 weeks later	5,609	955	1,702
20 pounds N 4 to 6 weeks after planting	5,589	711	1,334
40 pounds N 4 to 6 weeks after planting	5,609	849	1,364

[1] No grain produced.

An experiment consisting of 8 treatments in triplicate was conducted with sorghums during a 3-year period, 1948–50. The yields obtained showed a high experimental error, and in no case was there a significant difference between treatments, although there appeared to be some response in 1950 (table 19).

The experiment was revised in 1951, reducing the number of treatments to 6 and increasing the number of replications to 5 (table 20). The same treatments were used for cotton as for milo. Both crops were a total failure in 1952 and 1953, so data are available for only 1951. Results for this year show no significant differences due to treatment for either crop (table 20).

Table 20.—*Yields of milo grain and seed cotton under 5 different fertilizer treatments, Big Spring, Tex., 1951*

Fertilizer treatment per acre	Acre yields of—	
	Plainsman milo, grain	Seed cotton
	Pounds	*Pounds*
Check (no fertilizer)	237	519
40 pounds N at planting	176	554
60 pounds P_2O_5 at planting	149	585
60 pounds P_2O_5 and 40 pounds N at planting	182	596
40 pounds N 4 to 6 weeks after planting	116	583
60 pounds P_2O_5 at planting, 40 pounds N 4 to 6 weeks after planting	182	554

Up to the present time (1955) no appreciable benefit has been derived from applications of phosphorus, or nitrogen, or both, to sorghums or to cotton. It is apparent that if fertilizers are to be profitable, a tremendous response would be necessary in a favorable climatic year to make up for the expense incurred in a less favorable one. There is as yet no evidence that this will occur.

EFFECT OF CROPPING SYSTEMS ON THE SOIL

No analyses of the nitrogen and carbon contents of soil were made when the work was started, so there is no exact way of determining the change that has taken place in the period the land has been under cultivation.

In 1947 an effort was made to obtain an approximation of the changes that had taken place in the soils of the Great Plains under cultivation. The dryland stations offered an especially good field for such studies. Most of them were located on virgin land, and certain cropping systems or practices had been continuous from the time the work was started.

The original status of the soil on the different plots could not be determined, but an approximation could be made by assuming that the virgin status of the plots was the same as the 1947 status of land remaining in sod. Virgin areas of approximately the same soil texture as the plots were selected for purposes of comparison.

At Big Spring, the virgin area selected was 3 miles from the station. It is believed, however, that despite its distance from the station, it represents reasonably well the average status of the virgin soil of the plots.

Samples on the plots were taken on a number of cropping systems, such as continuous small grain, continuous row crops, alternate fallow and crops, and on 3 other rotations. The 1947 nitrogen content of the 0- to 6-inch sections of these cropping systems was compared with that of the virgin lands (table 21).

Table 21.—*Nitrogen status in 1947 on 9 cropping systems and on virgin sod, moisture equivalents of certain systems, and changes in nitrogen content, Big Spring, Tex.*

Cropping system or virgin land	Plots	Moisture equivalent, 0 to 12 inches	Nitrogen in 0- to 6-inch section of soil		
			1947 content	Change from virgin content	
				Based on 0.060 virgin content	Based on adjusted virgin content [1]
	Number	*Percent*	*Percent*	*Percent*	*Percent*
Wheat every year	2	14.5	0.051	−15	−26
Alternate wheat and fallow	2	16.0	.060	0	−21
Cotton every year	2	9.5	.031	−48	−31
Alternate cotton and fallow	2	10.3	.030	−50	−39
Milo every year	2	10.8	.033	−45	−35
Alternate milo and fallow	2	14.5	.037	−38	−46
Milo, fallow, fallow, fallow	4	11.6	.041	−32	−26
Wheat, milo, cowpeas	3		.042	−30	
Milo (topdressed with manure), cowpeas	2		.064	+7	
Virgin land		12.6	.060		

[1] The adjusted virgin content was based on the assumption that there was a linear relationship between the moisture equivalent and the original nitrogen content of the soil.

Such a comparison assumes that the original nitrogen levels of the different plots were equal to each other and to the virgin sod. This cannot be entirely true, but it was felt that wide differences due to cropping systems would be evident.

The results based on the assumption of original uniformity showed heavy losses in nitrogen on land where row crops were grown each year or were alternated with fallow, with the exception of the rotation receiving manure. Losses on land cropped to wheat each year or in alternate years were unbelievably small. It was amazing that land in cultivation for more than 30 years had retained so much of its original nitrogen.

The only available measurement of the original uniformity on the land was through moisture equivalents determined on many of the plots only a few years after they had been put under cultivation. These moisture equivalents (table 21) show that there were considerable differences between plots. The moisture equivalent is a measure of

texture as well as of the water-holding capacity of a soil. A higher moisture equivalent usually indicates a soil with a higher silt or clay content. In sandy soils like that at Big Spring, this is usually associated with a higher original organic matter and nitrogen content.

Virgin nitrogen values were calculated for the cropping systems for which moisture equivalent data were available. These values were calculated with the assumption that there was a linear relationship between the moisture equivalent of a soil and its original nitrogen content. The assumption is not entirely valid, but the calculated losses obtained through it (last column of table 21) make it appear far more valid than the assumption that all of the plots and the virgin area had the same original nitrogen content.

The rotation where stable manure was applied in alternate years appeared to maintain more soil nitrogen than the other systems, although in the absence of moisture equivalent determinations this was not certain. The yields of milo and cowpeas in this rotation were no higher than on similar rotations not receiving manure. Maintaining the nitrogen content by applications of manure was highly unprofitable.

The determinations as a whole show that land producing row crops has suffered a serious loss in nitrogen. How long such losses can continue without affecting yields adversely cannot be foretold. It is apparent, however, that the time will come when lack of fertility will reduce crop yields below the limitations fixed by climate. How best to meet the situation, when it arises, is one of the major unsolved problems.

SOIL MOISTURE STUDIES WITH MILO

Soil moisture studies with milo have been carried on for a long period. During the early years determinations were made early in spring and at intervals during the life of the crop, with particular emphasis on the planting and harvest dates. Later, the early-spring samples were omitted and the first sample was taken at planting time, which was usually in early June. Frequent samples were concentrated during the period of rapid growth, roughly from early July until harvest.

Samples for moisture determinations were taken in foot-sections with a King soil tube. Samples at harvest and planting were generally taken to a depth of 6 feet, and intermediate samples to a depth of 4 feet. Percentages were based on the dry weight of the cores. Conversion to inches of water was based on an average bulk density of 1.44 (90 pounds to the cubic foot of soil). The bulk density was based on the average dry weight of a large number of soil cores obtained in moisture determinations.

Storage of Moisture in Annually Cropped and in Fallowed Land

Storage of water in land cultivated by different methods offers one means of interpreting the causes of differences in yield resulting from their use. Relative water storage under the three major methods—fall plowing, spring plowing, and summer fallowing—were made over a long period. On land cropped each year, the period for storage of water extended from harvest to planting—about 8 months. For summer fallowing, the storage of water occurred from harvest until another crop was planted on the same land, a period of about 20 months. The average storage of water for the different methods was as follows: Spring plowing, 1.82 inches; fall plowing, 2.50 inches; and summer fallowing, 3.23 inches. This does not represent the entire quantity available at seeding, as sometimes rains just before harvest left a considerable residue of water in the soil at harvest.

Summer fallow stored quantities of water ranging from a gain of 6.40 inches for a period ending at planting in 1920 to a loss of 3.18 inches for a fallow period that ended with planting in 1934. In the latter case, the soil was well filled with water on all plots in the fall of 1932, but the moisture on the land to be fallowed and on the late spring-plowed plot was depleted before these plots were plowed in the late spring of 1933. Rainfall during 1933 was not sufficient to replenish the supply even on fallowed land.

Land that was dry to crops at the beginning of the fallow period and filled with moisture to near capacity at seeding stored 6 inches or slightly more of water. Lesser storage indicated that the soil was not dry at the beginning of the fallow period or was not filled to capacity at planting, or a combination of the two. In the majority of cases the soil was not filled to capacity at planting. The average storage on fallowed land was only 10.4 percent of the rainfall for the 20-month period.

The material difference in storage in favor of fall plowing over spring plowing led to further investigation of whether the difference was the result of lack of storage over winter on the spring-plowed land, or if the difference occurred during the spring period. It was shown in table 7 that the increase in yield from fall plowing over spring plowing was 6.3 bushels of milo during the period 1916–33 when the average date of spring plowing was May 9, but only 1.1 bushels for the period when the plowing date was advanced to April 2. The soil moisture data were accordingly examined to see whether moisture storage might account for at least part of the difference. During the period 1917–33, the fall-plowed plot stored 1.34

inches more water than the spring-plowed plot and produced a yield 6.9 bushels higher. During the period 1934–52 the fall-plowed plot stored only 0.07 inch more water and produced a yield only 1.3 bushels higher. Difference in moisture storage was evidently the principal factor contributing to the difference in yield.

The data did not show how much of the difference in moisture storage during the 2 periods was the result of the time of spring plowing and how much was caused by season. The difference in moisture content as a result of time of plowing was caused by a combination of 2 factors: (1) Loss of water from the soil of late-plowed plot before plowing, chiefly through weed growth, and (2) loss of water from the plow layer of the late-plowed plot resulting from plowing when temperatures were relatively high.

Loss of Water During the Fallow Period

The relatively low storage of water in summer fallow has led to the belief that water taken into the soil is lost during the hot periods that prevail during the summer months. The Big Spring observations gave a good opportunity to check on the accuracy of this belief, because long summer droughts occurred frequently. Periods during July, August, and September were selected when no rain or only light showers occurred between sampling dates. There were 35 of these periods selected, the average length of which was 27.6 days. Average losses of moisture in the different foot sections during the 27.6-day period were as follows:

	Inch
First foot	0.434
Second foot	.123
Third foot	.038
Fourth foot	−.020
Total	.575

The total loss of water from below the first foot was 0.141 inch for the 27.6-day dry period, or 0.005 inch per day. These rainless or nearly rainless periods were usually above average in temperature and in evaporation, and below average in humidity. It appears that loss of water below the first foot section was not a serious problem. Getting moisture into the soil to a depth below 1 foot was the main difficulty.

Even the first foot of soil was not completely dried out during these drought periods. The average moisture content of the first foot section was 7.2 percent at the end of the period. Where a milo crop was growing, the average water content at the end of the drought period was 4.8 percent, indicating that even after nearly a month of drought the first foot of soil on land being fallowed still contained a small quantity of moisture that would have been available to milo.

A study of moisture reduction of milo on fallowed land during July and August drought periods might afford some measure of the water necessary to maintain a milo crop in growing condition. The data from such a study did not give a satisfactory answer, because in many cases the crop did not get all of the water needed and its potential yield was accordingly reduced. The 4-foot samples taken during the growing season did not cover the whole zone of water removal. Available moisture, when present, is removed by milo to a depth of 6 feet or more.

The average daily reduction in water content to a depth of 4 feet by milo was 0.057 inch. There were only a few cases where the daily reduction exceeded 0.1 inch. The milo on fallowed land failed to produce grain in only 1 of the 26 years used in this study, so it is evident that milo can survive periods of drought on relatively small quantities of water. This is no doubt the reason why relatively small differences in quantities of water stored were associated with comparatively large differences in yield.

It should not be assumed that the quantities given in the above paragraph constitute the normal rate of water loss from the soil where a milo crop is growing. They do represent what was used when there was insufficient moisture in the first foot section, and most of the moisture removed was from below the depth where it could be removed rapidly by evaporation, and also below the depth of greatest root concentration.

Attempts were made to study the use of water during short periods, but the quantities removed were so small that experimental error made the results of doubtful value.

EFFECT OF CLIMATIC FACTORS ON YIELDS OF MILO AND COTTON

The determining effect of weather on crop yields made it seem desirable to study some of the climatic factors individually. Results are influenced by the fact that the different factors are interrelated, and it is not possible to separate entirely the individual effect from the combined effect.

Precipitation for different months and periods was correlated with yields of the two principal crops, milo and cotton (table 22).

Annual precipitation was closely related to yield. The highest correlation for both crops was for the 12-month period extending from September 1 through August the following year.

Correlations for the winter and spring (preseasonal) precipitation and yield were highly significant. Those for periods that included April were

Table 22.—*Correlations [1] between precipitation for specified periods and yields of milo and cotton, Big Spring, Tex., 1916–53*

Precipitation period	Coefficient of correlation [2] with—	
	Milo grain	Seed cotton
Annual:		
Jan. 1 to Dec. 31	0.618**	0.548**
Oct. 1 to Sept. 30	.624**	.587**
Sept. 1 to Aug. 31	.698**	.707**
Preseasonal:		
Oct. 1 to Mar. 31	.468**	.432**
Oct. 1 to Apr. 30	.656**	.517**
Sept. 1 to Mar. 31	.389**	.432**
Sept. 1 to Apr. 30	.630**	.572**
Nov. 1 to Apr. 30	.641**	.433**
12 months prior to Apr. 30	.536*	.474**
Seasonal:		
May 1 to Aug. 30	.460**	.532**
May 1 to Sept. 30	.404**	.454**
Apr. 1 to Sept. 30	.568**	.545**
Monthly:		
April	.461**	.295
May	−.009	.185
June	.360*	.272
July	.194	.170
August	.400*	.438**
September 9	.098	.084

[1] These correlations were made by W. C. Moldenhauer of the Big Spring station staff.
[2] * = significant at 5-percent level; ** = significant at 1-percent level.

invariably higher than for periods that ended with March.

Correlations for periods that included most of the active growth of the crop (seasonal) were also highly significant. They were higher when the precipitation for April was included. The correlations between preseasonal precipitation and yield tended to be higher than those for seasonal precipitation. This could, but does not necessarily, indicate that moisture stored in the soil at seeding time was more important than precipitation during the life of the crop. Factors other than precipitation may inhibit crop growth and influence yields—for instance, insect damage, summer maximum temperatures, wind velocity, and humidity. These factors are not operative during the preseason period. It appears that the precipitation for both periods is important, and also that rainfall during the growing season is not likely to compensate for a preseason deficiency.

Correlations for individual months were highest for April and August. The high April correlation probably explains why correlations for periods that included April were higher than for periods that did not include it.

Monthly average maximum, average mean, and average minimum temperatures were correlated with yield (table 23). Those for June, July, and August were negative, indicating that high temperatures were associated with reduced yields. For these 3 months, the average mean temperature showed the highest relationship. There was a positive correlation between September minimum temperatures and yields of both crops, although only that for milo was significant at the 5-percent level. The association between high September minimum temperatures and high yields probably indicates that such temperatures permitted better maturity of the crop in some seasons.

Evaporation was negatively correlated with yield (table 23). Only the correlation for August evaporation and yield of cotton was significant at the 1-percent level, but several others were significant at the 5-percent level.

Taking all three factors—temperature, precipitation, and evaporation—into consideration, it seems evident that August is the month when climate is most closely associated with yields of milo and cotton.

Correlations involving wind velocity were made, but none of them were significant and they are not presented.

COOPERATIVE EXPERIMENTS

Crop experiments in cooperation with other agencies of the Department [4] and with the State have been carried on for many years. Many of the results have been published (*3*, *4*, *5*, *7*, *8* (*pp. 506–522*)). The results are not presented here in detail, but some data not available elsewhere are reported and recommendations based on these cooperative studies are made.

Grain and Forage Sorghums

Experiments with these crops have consisted of variety tests and date and rate-of-planting tests. Variety tests with grain sorghums have been carried on since 1919. New varieties have been added from time to time and older varieties have been dropped when they had been tested and found wanting. The advent of varieties that could be harvested with a combine caused a major shift in the type of grain sorghum grown. However, Dwarf Yellow (Texas) milo, Reed and Dawn kafirs, and a few other standard taller growing varieties were continued for comparison.

The tests have shown that the better combine varieties yield as much or more grain as the types grown previously. A further shift in varieties was necessitated by the spread of certain plant diseases. For example, the spread of milo disease (periconia root rot) made inadvisable the production of varieties or strains not resistant to it.

Improvement in grain sorghums has been so rapid that variety recommendations are subject to frequent change. At the present time (1955)

[4] Experiments with grain and forage sorghums, cotton, cowpeas, soybeans, and grasses were in cooperation with the Field Crops Research Branch; those with peanuts were in cooperation with the Horticultural Crops Research Branch.

TABLE 23.—*Correlations* [1] *between temperatures and evaporation for specified months and yields of milo and cotton, Big Spring, Tex., 1916–53*

Temperatures	Coefficients of correlation [2] with—		Evaporation (monthly total)	Coefficients of correlation [2] with—	
	Milo, grain	Seed cotton		Milo, grain	Seed cotton
May:					
Average maximum	−0.066	−0.236	May	−0.151	−0.406*
Average mean	−.150	−.255	June	−.369*	−.328*
June:					
Average maximum	−.510**	−.410**	July	−.147	−.118
Average mean	−.529**	−.468	August	−.349*	−.560**
Average minimum	−.391*	−.291	September	−.163	−.293
July:					
Average maximum	−.343*	−.384*			
Average mean	−.506**	−.432**			
Average minimum	−.488*	−.504**			
August:					
Average maximum	−.541**	−.691**			
Average mean	−.541**	−.705**			
Average minimum	−.365*	−.522**			
September:					
Average maximum	−.045	−.175			
Average mean	.129	−.002			
Average minimum	.355*	.245			

[1] These correlations were made by W. C. Moldenhauer of the Big Spring station staff.
[2] *= significant at 5-percent level; **=significant at 1-percent level.

the varieties recommended by the Texas station for this area are as follows:

Combine type: Plainsman, Caprock, Martin, Westland, Midland
Hegari type: Early Hegari for combine; Dwarf Hegari for bundle feed and silage
Standard type: Texas milo, Texas Blackhill kafir, Reed kafir

Date-of-planting tests with sorghums have been carried on for many years. The first tests were intensive ones with a few varieties planted on a considerable number of dates. These revealed that there was a varietal response to time of planting. In later years all varieties were planted on 3 dates, approximately May 15, June 1, and June 15. It has been fairly well established that the early varieties, such as the combine types, were most productive when planted on the June 15 date. Standard varieties were generally as productive when planted June 1 as when planted later. Nearly all varieties produced materially lower yields when planted May 15 than when planted in June.

Some of the very early varieties can be planted as late as July 10 and still mature. Their use makes it possible to produce some crops in years when obtaining a stand of other varieties in mid-June has not been possible. Recent date-of-planting tests indicate that the very early varieties should not be planted after mid-June from choice. When stands can be obtained from mid-June planting, the same varieties as well as some other varieties produce higher average yields. The varieties recommended when planting must be done late are Early Hegari, 60-Day combine milo, and Midland.

Spacing experiments with grain sorghums were summarized by Martin and coworkers (*6, p. 19*) as follows: "The space required for a given variety is determined by two plant characters, viz, the ability to produce more tillers and the ability to produce larger heads, when the space per plant is increased." These workers found that the optimum spacing for most varieties could be determined by a spacing index calculated from these two factors. The best spacing within rows for sorghums in 44-inch rows (used in establishing the spacing index) ranged from 18 inches for Dwarf Yellow milo to 6 inches for most of the kafirs.

With the production of shorter varieties, such as the combine varieties, the question arose as to whether there should be some change from the spacings for standard varieties. Tests were accordingly made of combine sorghums in 22-inch and 44-inch rows, with different spacings in the row. The period in which this test was conducted was one of severe climatic conditions and relatively low yields. Difficulty was also experienced in obtaining comparable stands. The fragmentary data indicate that when the crop is planted in 44-inch rows, plant spacings in the row of much more than 6 inches are likely to result in decreased yields. Failure to obtain stands in one or the other row spacing made comparisons between 22-inch and 44-inch rows unreliable.

Forage sorghums have been grown for about the same period of years as grain sorghums. Varieties recommended for the Big Spring area are Sumac or Red Top, Sourless (African millet), and Saccaline. These combine leafiness and relatively small size of stalk, making them desirable for either fodder or ensilage. Most forage sorghums produced yields at least as high and a better quality of feed when planted June 15 than when planted earlier. The yields and forage value were highest when forage sorghums were

grown in row spacings of 6 inches or less. Such spacing produced a crop with small stalks, without decreasing the total yield. An experiment with Sunrise kafir showed a slightly higher yield when planted in cultivated rows than when seeded with a grain drill.

Sudan grass (fig. 9) produced a forage yield about half as much as that of the better forage sorghums. It produced a higher yield when planted June 1 than when planted later. Yields from drilled Sudan and from that planted in cultivated rows were about equal. Sudan grass is seldom grown in this area to be harvested as hay or forage. It is, however, the best annual pasture grass available.

FIGURE 9.—Sudan grass is a dependable forage crop, but its yield is much lower than that of forage sorghums. It is used chiefly for pasture.

Cotton

Cotton experiments have been centered on variety tests and spacing experiments. The variety tests have changed from year to year to include promising new varieties or strains. The varieties recommended for this section in 1955 by the Texas Agricultural Experiment Station include Hi-Bred, Deltapine 15, Native Mebane, Western Prolific, and Lone Star. These varieties are high yielding, and most of them have good quality and length of staple.

Although these varieties are the best for the area in yield, quality, and staple, they all produce open-type mature bolls, which are subject to storm damage when left in the field after maturity.

Mechanical harvesting is gradually replacing handpickers. The cotton stripper, the machine generally used in western Texas, requires a variety with storm-resistant bolls in which the seed cotton will remain long after frost or until it can be harvested (fig. 10). Recent cotton breeding efforts have been centered on the development of stormproof varieties, which, owing entirely to the economy of mechanical harvesting, are expected to replace open types in most of the western Texas cotton areas.

The following are among the best of the stormproof varieties available at the present time: Stormmaster, Western Stormproof, Native Mebane (stripper type), Lockett Stormproof, and Dunn No. 7.

Spacing tests showed that when cotton was planted in 44-inch rows, spacings from 12 to 18 inches in the row, with either 1 or 2 plants to the hill, were almost equally productive. Closer or wider spacings in the row or wider spacing between rows produced lower yields.

Cowpeas, Soybeans, and Guar

Experiments with cowpeas and soybeans have consisted entirely of variety tests. Cowpeas have proved to be fairly well adapted. Cowpea varieties recommended are New Era, Brabham, Groit, Iron, and Early Red.

Soybean yields have been relatively low. Laredo was the most productive of the long-established varieties, and its yields have not been exceeded by new varieties brought into the test in recent years.

Guar was planted for observation for several years in the late forties to determine its adaption to the area. It grew well, but the stalk was too woody and the foliage too scant to make it the equal of cowpeas as a green-manure crop. Recent interest in guar seed has led to a resumption of plantings. Its seed yield during these adverse years has not been encouraging, and its foliage has been injured considerably by a mosaic disease.

Peanuts

A small variety test of peanuts was maintained to provide information to those who might be interested in growing the crop. Peanuts have been subject to periodic spurts of popularity, but as mentioned earlier, their usefulness is limited by the hazard of soil blowing after they have been harvested. The varieties found best suited to conditions in this section are principally varieties or strains of Spanish-type peanuts, such as Valen-

FIGURE 10.—*A*, Defoliated cotton ready for the stripper; and *B*, typical loss incurred in cotton with open-type bolls harvested by machine.

cia, Spanish, McSpan, and Improved Spanish. Some larger seeded types have produced yields comparable with those of Spanish type, but the quality of nuts produced has generally been much poorer.

Grasses and Perennial Legumes

Grass work has been done on a very small scale, as lack of land severely restricted that type of work. The limited experiments performed indicate that adequate stands can be obtained in favorable years. Such stands, once well established, can persist despite unfavorable climatic conditions. They can be damaged or destroyed, however, by encroachment of blowing soil from adjoining cultivated land. For this reason grasses have not been adapted to plot work. Their general behavior indicates that perennial sod crops have no place in short rotations. The expense for land preparation, seed, and seeding is such that land reseeded to grass is best left undisturbed for a period of years, perhaps as long as it remains productive. Grass plantings should be in solid acreages to prevent or reduce injury resulting from soil blowing.

A grass mixture recommended for sandy upland soils in the low rainfall sections of the southern Great Plains (*8, p. 791*) consists of blue grama, 4 pounds; side-oats grama, 5 pounds; and sand lovegrass, 0.5 pound per acre. Proper seedbed preparation is one of the prime requisites for obtaining stands. Information on this subject is available in printed form (*8, pp. 506–522*) or may be obtained from the county agent or the State agricultural experiment station.

Sweetclover is the only perennial legume adapted to the upland soils of this area, and it is the only one that has been tried at the station. Good stands cannot be obtained regularly enough for it to have a place in crop rotations, although it occasionally produces good yields.

CROPPING SYSTEMS

The dryland farming area of West Texas has a very limited number of crops that can be produced profitably.

Cotton has a greater potential profit than any other adapted crop. Sorghums are well adapted, but their acre return is not high enough to make them profitable as the main cash crop. With present restrictions reducing cotton acreage to less than half of the cultivated acres, it is necessary that some kind of a farming system be devised for using grain and forage sorghums in connection with cotton.

A farmer interested in livestock can use the sorghums to produce the feed necessary for a feeding program. Forage sorghums make an excellent ensilage, comparable to corn. Grain sorghums can replace corn in any ration with nearly equal results. The use of livestock would be confined chiefly to dry lot or winter feeding programs. Few, if any, farmers have enough native pasture for a livestock program based on grazing. Sudan grass and other annuals are not regularly dependable because of frequent dry summers. A cropping system consisting of cotton, cowpeas, milo, and forage sorghum would meet the requirements of livestock feeders and at the same time provide for a cash crop.

Cropping systems can be adjusted to the needs of the individual farmer. Cotton as the principal cash crop, grain sorghums for sale or feed, and forage sorghums for roughage are basic crops. To these might be added cowpeas for a legume hay, Sudan grass for summer pasture, and winter wheat for pasture when conditions are favorable for fall growth.

The emphasis to be placed on the different crops depends on the type of farming enterprise. A farmer whose chief income is derived from sale of crops would use most of his acreage for cotton and grain sorghums. One with more interest in livestock would need to place more emphasis on feed crops, and perhaps on pasture. The kind of operation that a farmer can carry on depends not only on his preferences but also on the land available and the extent to which planted crops can be supplemented by pasture.

A flexible system is possible, since nearly all of the adapted crops are row crops and thus respond similarly to different sequences and cultural treatments. The acreage of one crop can be expanded or reduced without disturbing the operation of the system as a whole.

A rotation that has given consistently good results over the years is rotation 204, a 3-year rotation of cowpeas, cotton, and milo in the order named, all of them on fall-listed land. This rotation has several desirable features. While fall listing may not be the most productive method of tillage, it is a good one; it leaves a surface less susceptible to soil blowing during the winter and spring than plowing in the fall or leaving the land undisturbed. If done on the contour, it affords some protection against possible water erosion. Cotton, the cash crop, is grown in the favored sequence, following cowpeas. Cowpeas provide a legume hay useful in a system of farming that includes livestock production. Cowpeas produce so much less feed to the acre than forage sorghums, however, that few farmers would be likely to plant one-third of their land to this legume, despite its favorable effect on the crop following. Part or all of the cowpea acreage could be replaced by a grain, forage, or dual-purpose sorghum, according to the needs of the farmer. This would, of course, reduce the yield of the cotton crop to follow. The strong point of

such a cropping system is that performing all of the initial tillage at the same time permits adjustments in acreages of the different crops. Any manure produced on the farm could best be applied to the cotton crop, as it has shown more of a tendency to respond to manure than have the sorghums.

Cropping systems adapted to this area do not contain some of the elements considered necessary to good rotations in more humid areas. Introducing a grass or a perennial legume into the regular cropping system reduces the total yield without compensatory benefit. Plowing under an annual legume for soil improvement has been not only expensive, but also ineffective. There is no present known means of introducing what are commonly considered soil improving crops into the system without reducing the net income. The most feasible means of arresting or reducing soil deterioration appears to be by retiring part of the land to grass for pasture for a period of years. Some farmers might find it possible to do this, but others might not. When the time comes that fertility is more of a factor in determining the size of the crop than climate, it may be possible to introduce practices that add to fertility without suffering an economic loss.

SUMMARY

This report gives results of experiments in crop production at Big Spring, Tex., for the period 1916–53, inclusive.

Annual precipitation at the station averaged 18.31 inches, but it was erratic in distribution, ranging from 4.68 to 34.25 inches. Distribution in individual years was also erratic.

Cotton and the grain and forage sorghums were the most productive and dependable crops. Cowpeas were the best adapted leguminous hay crop. Sudan grass was dependable and was a valuable pasture crop. The yields when harvested for hay were only a little more than half as high as the yields of forage sorghums. Peanuts produced fairly good average yields, but were less dependable than the other crops mentioned.

Fall or early-winter plowing was superior to spring tillage for all crops. Fall listing seemed to be slightly less productive than fall plowing, but listing was a cheaper operation and provided better erosion control. Much of the reduction in yield resulting from spring tillage could be avoided by starting spring cultivation in late March or early April.

Early-spring surface tillage of land to be lister-planted was necessary for best yields on lister-planted land.

Fall plowing and subsoiling to a total depth of 16 to 18 inches produced slightly higher yields than ordinary fall plowing of all crops except milo. The increase was not enough to compensate for the greater cost for any crop except cotton. The yield of cotton on subsoiled land was exceeded by that of cotton lister-planted on ordinary fall plowing.

Summer fallowing produced the highest yield of most crops, but in no case was the increase great enough to make the practice profitable.

Sequence studies showed that yields of crops on cowpea land were generally higher than yields following cotton or sorghum.

Application of stable manure or the plowing under of a legume did not produce increases in yield great enough to cover the cost of either practice.

Growing sorghums and cotton in paired rows alternating with paired rows of annual legumes did not greatly affect the total production from a given area. An increased yield of one crop was usually accompanied by a decreased yield of the crop alternating with it.

Commercial fertilizers did not produce significant increases in the yields of milo or cotton during the 6 years (1948–53) that experiments were carried on.

Soil studies show that material losses in nitrogen have occurred during the time the land has been under cultivation, particularly on land where row crops were grown each year. Manure appeared to have more effect in maintaining the nitrogen content of the soil than on crop yields.

Soil-moisture studies show that only a small part of the precipitation for the fallow period is stored in the soil. Fallow stored less than an inch more water than fall-plowed milo land. Land being fallowed lost much of the water in the first foot-section during prolonged drought periods. Losses below the first foot-section were very small.

Correlations were made between climatic factors and yields of milo and cotton. Correlations between annual precipitation and yield were higher for both crops than correlations involving shorter periods. The highest correlation for an individual month was that between April rainfall and milo yields.

Temperatures during June, July, and August were negatively associated with yield. Evaporation was also negatively correlated with yield, but the correlations were not so high as those for temperature. Wind velocity was not significantly correlated with the yields of milo or cotton. August weather had more effect on yields of milo and cotton than did the weather for any other single month.

Variety, time of seeding, and plant-spacing recommendations are made on the basis of results from cooperative experiments.

Cropping systems should be built around the most productive and dependable crops, cotton and sorghums. Adapted varieties, planted at the optimum time and rate under the best methods

of tillage preparation, are essential to highest production. Best utilization of the sorghum crops appears to be through livestock. Acreage of crops other than cash crops can be regulated according to the needs of the livestock.

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APPENDIX

Table 24.—*Monthly and annual precipitation at the Big Spring, Tex., Field Station, 1916–53*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual total
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1916	0.13	0	1.74	2.12	0.14	1.59	2.48	4.31	0.87	1.30	1.01	0.10	15.79
1917	.28	0	.03	.97	.61	.98	.73	.17	.79	0	.12	0	4.68
1918	.60	.73	.09	.10	1.19	3.53	.16	.24	1.66	1.99	.74	1.32	12.35
1919	.57	.06	3.06	1.45	1.43	8.28	.95	3.60	7.43	6.31	.78	.09	34.01
1920	1.97	.20	.12	.08	5.32	1.33	.91	6.30	.69	1.95	2.22	.20	21.29
1921	.25	.90	1.15	.11	3.69	2.77	.45	.85	.71	.23	(1)	(1)	11.11
1922	.38	.08	1.73	12.77	2.36	2.89	.38	.22	0	1.15	1.35	0	23.31
1923	.29	3.01	2.16	4.58	1.24	2.61	1.68	.98	1.53	5.31	1.18	1.69	26.26
1924	.03	.50	.62	.91	3.62	.05	.96	2.03	.68	1.42	.05	.13	11.00
1925	.15	0	(1)	4.43	2.09	1.00	1.22	2.96	3.06	3.11	.14	0	18.16
1926	.98	.06	2.18	2.24	1.96	4.38	2.27	1.62	3.56	3.49	.32	2.19	25.25
1927	.53	1.69	.27	1.10	1.28	2.18	1.22	.42	4.00	.45	(1)	.42	13.56
1928	.35	.75	.02	.48	10.10	.95	1.87	2.68	.76	1.31	.71	.06	20.04
1929	.32	.85	2.89	.13	3.18	1.08	2.81	1.72	5.44	3.28	.74	0	22.44
1930	.46	0	.11	2.33	1.95	1.65	.68	2.18	.24	2.62	2.32	1.43	15.97
1931	1.31	.97	1.20	2.53	.75	.59	2.48	.95	.04	7.06	3.38	1.33	22.59
1932	1.12	3.81	.17	2.24	5.17	4.63	.23	4.68	8.70	.50	(1)	3.00	34.25
1933	.11	.79	.18	.05	.96	.16	1.41	4.76	.64	.54	1.15	.54	11.29
1934	.31	.56	1.50	1.73	.08	1.25	.99	2.94	.91	.17	1.60	.05	12.09
1935	.13	1.32	1.88	1.16	4.60	5.98	.88	1.54	3.93	2.59	1.48	.46	25.95
1936	.16	.03	1.94	.51	4.55	.48	.95	0	10.52	1.90	.58	.63	22.25
1937	.44	.09	1.51	.63	3.36	1.14	.89	1.95	.34	1.35	1.58	1.56	14.84
1938	1.91	1.76	.33	.95	1.80	6.85	5.35	.45	.11	1.06	.73	.02	21.32
1939	2.71	.13	.06	.44	2.90	2.61	1.45	2.47	0	.81	1.21	.66	15.45
1940	.40	1.08	.09	.55	1.82	5.03	.07	3.03	.19	1.44	1.81	.62	16.13
1941	1.19	1.02	3.14	2.84	4.89	4.19	3.10	2.06	3.62	3.94	.18	1.45	31.62
1942	.10	.30	0	2.57	1.85	1.27	.54	8.43	4.26	1.47	.08	2.81	23.68
1943	.20	.02	.86	.25	4.44	.93	3.05	.10	.28	.18	1.17	2.76	14.24
1944	1.05	2.62	(1)	.14	2.90	1.36	2.13	.99	1.64	.90	2.70	1.36	17.79
1945	.85	.29	1.94	0	.68	1.15	9.25	6.06	1.65	3.03	.03	.38	25.31
1946	1.42	.13	.56	.12	1.08	1.80	.09	1.21	2.31	2.68	.16	1.47	13.03
1947	.58	.05	1.54	(1)	4.51	.72	1.42	.02	.70	.56	1.49	1.35	12.94
1948	.10	.75	.16	0	.94	1.16	5.79	1.11	.02	2.08	0	.36	12.47
1949	2.14	.90	.31	2.23	4.42	2.76	.52	.91	1.43	1.91	0	.56	18.09
1950	.88	.30	0	2.60	7.99	1.62	4.26	.71	2.39	0	0	0	20.75
1951	.09	.14	.56	.38	2.06	1.95	2.28	2.42	1.00	.94	.12	.22	12.16
1952	.10	.23	.22	.51	.82	0	.71	.71	3.22	0	1.61	1.07	9.20
1953	.03	.39	1.91	1.20	.71	.29	.67	.70	.55	6.35	.12	.13	13.05
Average	.65	.70	.95	1.51	2.72	2.19	1.77	2.07	2.10	1.98	.87	.80	18.31

[1] Trace.

TABLE 25.—*Monthly and seasonal evaporation, Big Spring, Tex., Field Station, 1916–53*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total, seasonal Apr.–Sept.	Total, annual
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1916				6.61	10.84	13.29	10.44	9.24	7.71				58.13	
1917				10.01	10.87	13.38	13.16	12.25	8.13				67.80	
1918				9.67	11.33	10.62	13.24	12.64	8.43				65.93	
1919				6.99	8.35	8.03	10.27	10.58	6.67				50.89	
1920				8.75	8.29	9.35	12.48	6.99	7.06				52.92	
1921				9.21	9.11	9.13	11.51	12.84	8.82				60.62	
1922				8.48	8.46	8.79	12.93	11.67	9.69				60.02	
1923				5.95	8.85	9.79	10.37	10.33	6.93				52.22	
1924				7.18	8.18	11.56	10.87	11.09	7.43				56.31	
1925				8.23	8.17	11.24	11.87	8.10	6.42				54.03	
1926				5.40	8.29	10.15	9.98	10.11	7.67				51.60	
1927				8.58	11.71	10.37	10.15	12.12	7.06				59.99	
1928				8.37	7.44	10.96	9.71	7.17	6.94				50.99	
1929				7.33	7.22	10.69	9.28	10.10	6.86				51.48	
1930				6.06	8.12	8.71	11.65	10.23	9.18				53.95	
1931				5.61	7.55	9.47	9.55	9.55	9.21				50.94	
1932				7.50	6.51	7.90	9.73	8.03	3.95				43.62	
1933				8.17	9.08	11.41	10.38	8.32	7.00				54.36	
1934				7.04	10.15	12.57	12.08	11.72	8.72				62.28	
1935				8.23	7.79	7.66	9.10	9.34	4.40				46.52	
1936				8.59	7.46	10.30	10.98	11.36	6.32				55.01	
1937				8.00	8.94	10.31	11.33	10.93	8.09				57.60	
1938				7.80	10.87	9.28	9.09	10.79	9.00				56.83	
1939				8.94	9.03	11.97	11.77	9.06	9.89				60.66	
1940				8.82	9.03	8.70	11.68	8.53	8.17				54.93	
1941				5.67	6.11	7.23	8.74	9.07	6.50				43.32	
1942				7.01	9.16	10.26	11.67	7.87	5.68				51.65	
1943				9.51	8.61	9.96	9.65	12.95	7.34				58.02	
1944				8.60	8.23	10.07	10.99	10.48	6.79				55.16	
1945				6.50	10.82	11.32	7.25	7.99	7.98				51.86	
1946				7.27	8.50	9.15	10.90	10.46	5.65				51.93	
1947	3.90	3.02	3.22	6.28	7.54	9.68	11.22	9.99	8.32	5.79	3.21	2.08	53.03	74.25
1948	2.15	2.39	6.06	8.53	9.16	10.02	9.51	10.83	7.03	4.33	4.29	3.19	55.08	77.49
1949	1.16	2.30	4.73	4.70	6.62	9.09	9.98	9.48	6.14	4.67	3.70	2.23	46.01	64.80
1950	2.80	3.27	5.43	7.25	7.39	9.12	8.39	9.84	5.72	5.09	4.68	1.81	47.71	70.79
1951	4.15	3.64	5.26	8.05	8.76	9.65	10.65	11.29	8.54	6.05	3.32	3.66	56.94	83.02
1952	3.50	4.63	6.34	8.40	10.04	12.09	10.45	12.14	7.23	6.94	3.62	2.66	60.35	88.04
1953	4.04	3.61	5.58	8.62	10.07	12.61	11.14	9.00	9.33	7.59	2.90	3.33	60.77	87.82
Average	3.10	3.27	5.23	7.68	8.75	10.15	10.64	10.12	7.42	5.78	3.67	2.71	54.76	78.03

TABLE 26.—*Annual and average yields of milo grain, kafir grain, feterita grain, corn grain, and winter wheat grain on land cropped each year under the same tillage method, or alternately fallowed and cropped, Big Spring, Tex., 1916–53* [1]

Crop	Previous crop	Tillage method [2]	Acre yield in— 1916	1917	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929
			Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Milo	Milo	S. P.	18.1	0.3	49.1	14.1	7.8	25.3	11.0	2.2	10.0	20.0	5.0	20.3	4.3
	do	F. P.	18.8	2.8	47.4	30.3	24.0	25.5	28.4	5.7	11.0	18.3	17.2	21.4	11.4
	do	F. P. and SS	34.2	10.9	54.8	31.6	17.2	21.0	20.5	0	8.6	14.0	10.5	10.9	4.1
	do	L. P.	14.2	2.0	44.7	13.1	6.6	5.9	0	0	6.7	7.1	2.6	10.3	1.4
	do	C. and L. P.	21.4	3.9	42.9	17.6	11.4	7.8	19.3	0	6.7	14.8	9.3	14.3	5.7
	Fallow	Fallowed	36.0	23.2	72.6	29.0	35.9	25.3	36.7	6.6	12.9	29.3	26.4	34.1	32.8
Kafir	Kafir	S. P.	13.3	0	36.3	25.8	17.0	19.8	6.7	2.7	13.0	18.3	8.3	20.2	8.0
	do	F. P.	11.2	0	45.0	31.5	20.7	18.7	13.8	7.7	15.3	23.3	11.0	19.8	7.5
	do	F. P. and SS	22.8	.3	45.8	27.5	21.3	21.7	13.2	7.2	12.7	21.7	9.8	18.8	7.2
	do	L. P.	16.8	0	28.8	17.3	10.5	14.3	17.3	8.3	9.2	15.5	5.8	19.7	8.8
	do	C. and L. P.	25.2	.8	32.7	17.8	13.8	17.5	13.7	6.7	9.7	25.0	12.2	16.7	6.8
	Fallow	Fallowed	28.5	4.7	38.7	26.2	26.3	19.8	14.2	10.3	19.3	33.8	19.8	27.3	21.8
Feterita	Feterita	S. P.	7.1	0	30.0	8.3	3.6	19.5	6.6	2.6	4.0	17.4	6.7	14.1	2.8
	do	F. P.	8.1	0	34.5	25.3	14.7	19.5	15.7	4.7	7.1	25.0	11.7	16.0	6.2
	Fallow	Fallowed	22.8	7.0	37.6	23.3	19.7	21.4	20.7	9.8	12.8	28.4	20.9	23.8	15.5
Corn	Corn	S. P.	4.3	0	12.9	4.4	0	8.3	3.4	0	.3	2.4	0	7.3	0
	do	F. P.	14.1	.7	17.0	20.9	4.6	7.9	11.9	1.6	5.7	12.7	1.6	15.0	1.1
	do	F. P. and SS	11.1	.5	19.6	22.1	7.4	8.4	14.3	1.4	6.7	21.7	3.4	21.4	3.7
	do	L. P.	1.1	0	8.8	10.0	0	3.3	.7	0	.3	4.6	0	12.3	0
	do	C. and L. P.	1.4	0	4.6	9.0	0	2.0	7.7	.7	0	3.6	0	12.0	0
	Fallow	Fallowed	11.9	1.6	21.4	22.9	5.8	8.6	13.9	1.7	5.9	22.1	3.4	20.4	9.6
Winter wheat	Wheat	L. F. P.	0	5.8	2.3	17.8	.7	0	1.3	1.0	0	3.5	.8	.7	0
	do	E. F. P.	0	7.2	1.7	16.5	1.8	0	2.5	2.2	0	7.3	1.7	1.3	2.5
	do	E. F. P. and SS	0	10.3	21.3	18.8	.8	0	1.5	2.5	0	4.8	.8	4.0	1.0
	Fallow	Fallowed	0	7.2	11.2	14.3	5.8	0	2.0	6.2	0	9.7	.8	1.5	4.0

Crop	Previous crop	Tillage method	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941
Milo	Milo	S. P.	5.7	17.1	22.2	0	14.5	15.3	6.0	24.1	33.4	22.9	21.2	44.1
	do	F. P.	18.6	22.4	23.8	18.3	29.5	17.1	18.8	26.9	29.1	28.6	11.4	40.3
	do	F. P. and SS	7.8	24.8	31.6	25.5	21.4	23.8	11.0	25.5	34.3	23.3	8.3	49.7
	do	L. P.	1.7	0	8.8	0	0	20.0	1.0	18.8	17.8	5.7	6.0	17.2
	do	C. and L. P.	5.9	22.4	21.4	0	23.4	18.8	.7	22.6	30.7	15.2	11.9	33.6
	Fallow	Fallowed	20.3	35.3	30.0	25.2	17.2	28.1	19.0	30.2	34.1	36.2	42.4	43.1
Kafir	Kafir	S. P.	4.7	9.2	30.0	18.8	15.2	13.3	4.3	14.2	27.5	15.7	10.7	37.3
	do	F. P.	10.5	26.7	29.3	16.7	15.7	17.2	10.2	20.0	28.5	18.8	14.2	37.2
	do	F. P. and SS	8.2	29.7	31.5	21.3	15.0	17.2	18.2	20.0	28.0	28.3	21.3	32.5
	do	L. P.	5.8	0	13.5	10.2	0	11.5	0	15.2	24.2	16.7	19.7	31.0
	do	C. and L. P.	6.8	20.5	28.0	17.3	14.7	20.0	8.8	14.3	30.7	33.8	25.0	31.3
	Fallow	Fallowed	13.5	41.3	25.0	15.0	20.0	18.3	14.7	19.3	29.7	33.0	26.7	30.8
Feterita	Feterita	S. P.	3.6	7.2	17.6	0	11.9	25.9	1.4	16.9	31.0	10.5	3.1	26.4
	do	F. P.	5.7	17.8	17.9	29.3	13.4	33.6	7.1	19.0	28.3	12.6	3.3	20.3
	Fallow	Fallowed	12.2	25.9	14.5	29.8	25.5	41.2	10.2	30.3	34.7	31.2	14.5	22.1
Corn	Corn	S. P.	0	0	13.6	3.9	.7	10.0	.9	2.8	1.0	3.6	7.6	15.3
	do	F. P.	3.7	11.0	11.7	7.9	.9	9.3	1.9	1.4	.8	3.8	10.4	11.7
	do	F. P. and SS	4.6	12.7	13.1	8.6	1.7	13.7	4.6	7.1	1.5	6.1	14.2	12.9
	do	L. P.	0	0	.7	0	0	1.0	0	3.9	1.4	1.1	20.4	16.7
	do	C. and L. P.	0	0	7.9	9.4	.4	9.3	0	2.5	1.7	2.2	15.3	14.6
	Fallow	Fallowed	8.7	19.4	12.1	11.3	1.9	13.1	.7	2.8	1.1	5.6	12.6	8.8
Winter wheat	Wheat	L. F. P.	1.8	5.0	28.5	8.5	2.8	.5	0	2.8	0	0	0	19.2
	do	E. F. P.	2.0	2.0	28.2	5.5	13.0	2.0	0	8.8	0	3.0	0	33.5
	do	E. F. P. and SS	3.3	1.0	34.5	10.2	13.0	1.7	0	7.5	0	1.0	0	20.2
	Fallow	Fallowed	1.7	3.3	12.0	5.2	11.2	3.3	.5	9.2	0	2.8	0	22.2

Crop	Previous crop	Tillage method	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1953	Average, 1916–53
Milo	Milo	S. P.	27.6	29.1	20.0	36.4	8.8	17.2	12.9	21.6	30.7	2.4	0.7	16.4
	do	F. P.	28.6	22.4	20.3	35.0	20.0	13.1	13.4	23.1	28.4	4.0	.5	19.9
	do	F. P. and SS	34.3	19.5	21.7	39.7	17.9	10.0	12.6	16.2	30.3	6.6	.2	19.3
	do	L. P.	6.2	1.4	2.2	16.9	4.1	2.2	0	3.3	29.3	2.2	.2	7.4
	do	C. and L. P.	20.3	10.3	7.9	30.9	13.1	8.3	6.0	6.0	34.7	5.3	.2	13.8
	Fallow	Fallowed	25.5	16.0	28.6	41.2	21.4	11.4	31.2	20.9	32.4	13.1	.5	26.4
Kafir	Kafir	S. P.	15.5	16.0	10.8	28.2	11.0	9.2	8.2	9.3	11.5	1.3	0	13.5
	do	F. P.	17.3	16.7	10.7	28.3	10.7	6.7	6.3	13.8	17.7	2.3	0	15.8
	do	F. P. and SS	15.0	13.8	10.5	28.5	16.5	10.5	10.5	17.7	28.2	6.0	0	17.3
	do	L. P.	10.7	12.5	8.5	20.8	13.0	10.5	8.5	11.5	18.3	7.2	0	11.6
	do	C. and L. P.	13.8	22.5	8.8	28.8	13.8	12.2	11.5	12.5	29.2	12.3	0	16.2
	Fallow	Fallowed	13.8	15.2	15.8	26.5	18.3	9.0	25.8	16.7	31.5	17.7	0	20.2
Feterita	Feterita	S. P.	20.0	0	6.9	24.3	7.9	5.7	3.6	4.5	9.7	.9	4.3	9.6
	do	F. P.	14.5	0	9.1	26.4	4.5	4.0	6.6	6.0	8.6	.5	2.6	12.6
	Fallow	Fallowed	18.8	0	11.7	31.7	12.2	8.1	10.3	6.2	26.9	7.9	3.3	18.2
Corn	Corn	S. P.	4.3	13.3	1.7	2.4	0	9.4	0	8.6	2.5	0	0	3.8
	do	F. P.	5.3	15.0	2.5	1.8	0	9.7	0	11.8	3.1	.7	0	6.3
	do	F. P. and SS	8.8	19.9	3.8	2.2	0	16.1	2.9	8.9	4.4	2.9	0	8.2
	do	L. P.	2.9	6.9	0	1.3	0	16.9	2.6	8.8	2.9	2.4	0	3.4
	do	C. and L. P.	9.4	19.4	3.8	2.8	0	18.5	4.3	12.5	4.7	1.7	0	4.8
	Fallow	Fallowed	6.1	16.5	1.3	1.4	0	16.4	0	13.6	4.3	1.9	0	8.1
Winter wheat	Wheat	L. F. P.	7.3	2.5	0	3.8	.8	3.3	1.7	5.0	2.5	0	0	[3] 3.5
	do	E. F. P.	8.8	5.0	0	3.7	8.8	4.7	2.7	4.7	5.0	0	0	[3] 4.8
	do	E. F. P. and SS	7.7	.8	0	2.0	6.2	4.3	2.3	5.2	5.3	0	0	[3] 5.2
	Fallow	Fallowed	8.3	8.0	0	5.2	5.3	6.7	4.2	5.0	6.7	0	0	[3] 5.0

[1] All crops failed in 1918 and 1952. These years are included in the average.

[2] S. P., spring-plowed; F. P., fall-plowed; F. P. and SS, fall-plowed and subsoiled; L. P., lister-planted; C. and L. P., cultivated and lister-planted; L. F. P., late fall-plowed; E. F. P., early fall-plowed; E. F. P. and SS., early fall-plowed and subsoiled.

[3] 37-year average.

TABLE 27.—*Annual and average yields of seed cotton, broomcorn brush, sorgo fodder, and kafir stover on land cropped each year under the same tillage method, or alternately fallowed and cropped, Big Spring, Tex., 1916–53*

Crop	Previous crop	Tillage method [1]	Acre yields in— 1916	1917	1918	1919	1920	1921	1922	1923	1924	1925
			Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Seed cotton	Cotton	S. P.	20	30	270	1,380	990	310	560	480	240	410
	do	F. P.	450	20	220	1,270	1,550	470	530	1,040	580	690
	do	F. P. and SS	400	80	280	1,520	1,640	530	610	1,060	570	930
	do	L. P.	40	10	280	1,250	920	400	610	800	290	590
	do	F. P. and L. P.	340	50	180	1,250	1,390	530	630	1,130	445	765
	do	F. L. and L. P.	400	90	300	1,470	1,290	590	560	1,140	600	825
	Fallow	Fallowed	570	40	260	1,520	1,260	670	500	1,080	660	1,050
Broomcorn brush	Broomcorn	S. P.	325	0	0	750	190	30	390	140	50	50
	do	F. P.	475	220	0	600	630	350	400	390	190	330
	do	F. P. and SS	515	175	0	580	650	360	430	320	150	290
	do	L. P.	100	0	0	355	285	150	440	290	230	140
	do	C. and L. P.	110	30	60	540	310	270	500	280	240	130
	Fallow	Fallowed	600	260	340	680	730	450	430	430	150	400
Sorgo fodder	Sorgo	S. P.	9,320	1,540	5,940	12,900	10,980	2,900	6,890	2,220	2,160	4,280
	do	F. P.	12,520	2,860	5,100	13,500	13,440	4,780	8,400	6,400	3,380	4,920
	do	F. P. and SS	10,480	770	1,640	11,120	13,500	6,760	6,440	7,000	3,600	4,580
	do	L. P.	3,740	20	920	11,300	9,520	2,240	2,600	0	1,670	3,580
	do	C. and L. P.	5,600	400	1,360	10,840	11,800	5,620	4,440	6,100	3,920	3,960
	Fallow	Fallowed	16,160	3,240	9,540	16,200	13,900	11,440	9,330	8,000	5,120	5,880
Kafir stover	Kafir	S. P.	2,300	205	1,050	4,520	3,350	2,140	2,030	1,200	1,400	2,300
	do	F. P.	5,370	80	1,250	4,240	4,590	2,480	2,020	1,570	2,760	3,400
	do	F. P. and SS	6,530	260	1,240	5,450	4,970	2,400	2,470	1,910	2,870	3,250
	do	L. P.	2,970	0	910	3,730	2,760	1,450	1,640	2,440	3,200	2,090
	do	C. and L. P.	4,725	180	1,490	4,360	2,830	1,710	1,890	1,620	2,860	2,030
	Fallow	Fallowed	7,870	1,235	2,000	6,240	4,130	3,100	2,610	1,890	3,080	4,620

Crop	Previous crop	Tillage method [1]	Acre yields in— 1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
Seed cotton	Cotton	S. P.	410	90	760	290	390	300	610	0	535	890
	do	F. P.	790	500	910	560	540	850	750	880	630	840
	do	F. P. and SS	950	600	1,050	540	690	790	830	1,310	540	1,160
	do	L. P.	300	50	940	310	340	310	500	0	600	1,125
	do	F. P. and L. P.	880	480	980	390	560	590	940	1,520	460	1,275
	do	F. L. and L. P.	780	500	1,080	600	560	680	580	950	600	900
	Fallow	Fallowed	1,010	830	1,140	1,160	750	1,050	630	630	800	510
Broomcorn brush	Broomcorn	S. P.	170	200	430	260	0	0	400	0	230	260
	do	F. P.	530	190	450	240	200	240	310	0	240	310
	do	F. P. and SS	610	190	430	270	250	270	310	0	260	440
	do	L. P.	400	290	330	280	200	220	230	0	0	200
	do	C. and L. P.	450	280	300	300	220	300	330	0	200	450
	Fallow	Fallowed	610	370	500	450	320	480	390	0	200	480
Sorgo fodder	Sorgo	S. P.	7,500	2,580	6,640	4,400	3,470	4,960	10,060	0	6,600	8,000
	do	F. P.	8,120	4,420	6,100	6,800	3,880	5,800	9,960	9,000	4,800	7,400
	do	F. P. and SS	8,700	5,200	6,880	6,100	4,740	5,800	10,660	9,900	5,000	7,840
	do	L. P.	7,920	1,700	6,360	4,200	1,920	1,900	5,960	0	0	2,240
	do	C. and L. P.	11,320	6,580	7,600	4,500	4,550	4,500	7,440	3,500	5,600	5,940
	Fallow	Fallowed	12,540	9,400	9,220	12,200	5,120	8,000	10,000	9,700	5,200	10,200
Kafir stover	Kafir	S. P.	1,700	1,400	2,310	2,980	1,500	1,480	2,830	1,400	2,090	1,430
	do	F. P.	2,100	1,510	2,460	2,350	2,350	2,530	2,860	2,250	2,060	2,480
	do	F. P. and SS	2,200	1,790	2,530	2,450	2,540	2,430	2,740	1,830	1,980	1,850
	do	L. P.	1,830	930	2,300	2,900	1,180	0	2,310	1,190	0	1,060
	do	C. and L. P.	2,130	1,780	2,450	2,090	1,440	1,650	2,080	1,530	1,380	1,980
	Fallow	Fallowed	3,600	2,510	3,660	4,760	2,810	3,150	2,630	1,530	1,930	2,680

See footnote at end of table.

TABLE 27.—*Annual and average yields of seed cotton, broomcorn brush, sorgo fodder, and kafir stover on land cropped each year under the same tillage method, or alternately fallowed and cropped, Big Spring, Tex., 1916–53*—Continued

Crop	Previous Crop	Tillage method [1]	Acre yields in— 1936	1937	1938	1939	1940	1941	1942	1943	1944	1945
			Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Seed cotton	Cotton	S. P	260	850	650	610	750	1,190	440	460	680	580
	do	F. P	490	990	700	610	750	1,010	640	600	740	580
	do	F. P. and SS	610	1,290	810	1,080	990	1,180	760	780	1,190	1,010
	do	L. P	330	990	1,040	890	1,130	1,440	690	750	1,000	1,180
	do	F. P. and L. P	600	1,290	1,090	1,010	1,000	1,490	810	830	1,200	1,200
	do	F. L. and L. P	550	1,390	1,010	1,030	1,030	1,110	740	790	1,260	480
	Fallow	Fallowed	500	1,150	740	940	1,410	790	560	740	1,030	440
Broomcorn brush	Broomcorn	S. P	0	90	580	240	240	650	150	400	250	250
	do	F. P	150	100	530	260	280	400	210	380	250	240
	do	F. P. and SS	180	160	550	330	310	410	250	340	260	160
	do	L. P	40	230	430	350	260	300	190	210	190	150
	do	C. and L. P	140	160	490	340	240	330	140	280	210	100
	Fallow	Fallowed	160	180	560	380	430	190	200	280	250	180
Sorgo fodder	Sorgo	S. P	3,400	3,270	6,800	3,130	4,500	11,500	6,250	4,380	6,250	6,940
	do	F. P	3,400	4,770	6,400	3,630	3,880	10,000	6,250	4,130	6,880	6,380
	do	F. P. and SS	3,800	5,180	8,100	3,630	3,880	11,250	5,000	4,750	6,250	7,690
	do	L. P	400	1,350	3,800	2,380	1,500	6,250	1,500	1,000	2,500	8,690
	do	C. and L. P	2,400	2,440	7,900	4,380	4,880	10,000	4,880	5,250	6,250	8,440
	Fallow	Fallowed	5,100	5,400	10,500	6,250	7,500	11,880	6,630	6,500	10,750	9,690
Kafir stover	Kafir	S. P	2,000	1,790	2,350	1,440	2,610	5,390	2,880	2,160	2,100	2,250
	do	F. P	1,890	2,650	2,540	1,630	2,400	5,030	2,500	2,630	2,610	2,430
	do	F. P. and SS	2,290	2,650	3,080	2,180	2,480	4,550	3,000	2,550	3,250	2,410
	do	L. P	1,750	2,180	2,300	1,630	2,450	4,140	2,630	2,000	2,250	3,440
	do	C. and L. P	2,000	2,160	3,790	2,600	2,630	4,380	2,630	3.150	3,230	3,460
	Fallow	Fallowed	2,000	2,760	3,230	2,530	3,400	4,650	2,880	2,210	3,480	4,350

Crop	Previous crop	Tillage method [1]	Acre yields in— 1946	1947	1948	1949	1950	1951	1952	1953	Average, 1916–53
Seed cotton	Cotton	S. P	130	680	310	690	740	210	0	0	479
	do	F. P	400	700	440	790	950	240	0	175	655
	do	F. P. and SS	490	1,050	340	1,100	1,400	460	0	265	813
	do	L. P	440	950	440	500	1,280	460	0	200	615
	do	F. P. and L. P	520	1,150	690	1,250	1,490	690	0	375	828
	do	F. L. and L. P	540	960	290	1,210	830	730	0	300	756
	Fallow	Fallowed	460	980	560	1,200	910	1,230	0	450	795
Broomcorn brush	Broomcorn	S. P	60	260	190	130	310	60	0	0	204
	do	F. P	80	240	390	160	310	100	0	0	273
	do	F. P. and SS	110	260	300	200	350	130	0	0	284
	do	L. P	50	160	130	90	230	110	0	0	191
	do	C. and L. P	80	210	290	130	310	160	0	0	234
	Fallow	Fallowed	80	280	230	140	330	340	0	0	328
Sorgo fodder	Sorgo	S. P	750	3,380	2,100	1,630	3,750	880	0	1,400	4,833
	do	F. P	3,130	3,380	4,000	1,880	2,500	1,380	0	1,060	5,648
	do	F. P. and SS	3,130	5,250	5,000	2,500	5,000	2,130	0	1,850	5,818
	do	L. P	0	1,250	2,500	2,500	3,130	2,000	0	950	2,881
	do	C. and L. P	500	3,250	3,500	2,380	4,630	1,500	0	1,860	5,000
	Fallow	Fallowed	3,000	4,880	6,800	2,880	5,630	5,380	0	2,180	7,930
Kafir stover	Kafir	S. P	960	1,200	2,260	1,310	1,500	1,250	0	1,910	1,973
	do	F. P	1,860	1,230	1,380	1,430	1,560	1,640	0	1,360	2,302
	do	F. P. and SS	2,140	1,530	2,500	1,810	2,190	2,510	0	1,480	2,534
	do	L. P	1,100	1,630	1,990	1,190	1,400	1,480	0	0	1,801
	do	C. and L. P	2,050	2,550	3,060	1,750	2,250	2,760	0	0	2,280
	Fallow	Fallowed	2,650	2,210	3,950	2,130	3,610	3,060	0	2,310	3,091

[1] S. P., spring-plowed; F. P., fall-plowed; F. P. and SS., fall-plowed and subsoiled; L. P., lister-planted; C. and L. P., cultivated and lister-planted; F. P. and L. P., fall-plowed and lister-planted; F. L. and L. P., fall-listed and lister-planted.

TABLE 28.—*Yields of milo, cotton, and cowpeas in manured and unmanured 4-year rotations, Big Spring, Tex., 1916–53*

Crop	Previous crop and manure treatment	Rotation No.	Acre yield in— 1916	1917	1918	1919	1920	1921	1922	1923	1924	1925
Milo grain, bushels	Manured fallow	273	12.8	7.1	8.1	51.2	32.9	31.2	31.6	40.5	8.3	11.4
	Unmanured fallow	223	9.8	3.4	1.6	49.3	31.6	27.6	26.4	30.9	9.0	18.6
	Cowpeas in manured rotation [1]	272	11.7	.3	0	50.5	31.2	13.6	28.6	32.6	4.7	14.1
	Cowpeas in unmanured rotation	222	28.2	7.2	3.6	53.8	33.1	20.9	31.2	31.6	6.6	14.8
Seed cotton, pounds	Manured fallow	272	60	40	100	1,080	1,270	580	590	1,250	520	1,010
	Unmanured fallow	222	40	20	250	1,340	1,360	610	610	1,160	530	1,210
	Cowpeas in manured rotation [1]	273	30	80	150	1,110	1,720	430	600	880	290	520
	Cowpeas in unmanured rotation	223	10	10	100	1,100	1,330	450	580	1,030	530	610
Cowpea hay, pounds	Milo in manured rotation [2]	273	2,600	50	800	2,220	3,780	2,740	2,060	2,320	0	560
	Milo in unmanured rotation	223	2,550	10	760	1,860	2,600	2,200	2,140	1,540	0	520
	Cotton in manured rotation [2]	272	2,100	100	1,520	1,340	4,000	2,380	2,200	1,500	0	920
	Cotton in unmanured rotation	222	3,350	70	1,160	1,120	4,100	1,980	2,300	1,880	0	600

Crop	Previous crop and manure treatment	Rotation No.	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
Milo grain, bushels	Manured fallowed	273	29.3	32.6	20.5	27.2	13.6	34.7	34.3	38.6	11.2	37.1
	Unmanured fallow	223	20.9	30.9	24.1	20.7	22.4	40.5	31.0	34.7	27.2	35.2
	Cowpeas in manured rotation [1]	272	6.2	11.2	47.2	18.6	.9	7.6	34.5	28.4	6.0	39.8
	Cowpeas in unmanured rotation	222	9.3	14.0	43.1	13.4	.7	16.0	27.8	26.4	8.6	32.4
Seed cotton, pounds	Manured fallow	272	850	900	930	940	750	940	910	1,060	860	1,790
	Unmanured fallow	222	830	700	890	850	580	900	600	1,025	540	1,125
	Cowpeas in manured rotation [1]	273	580	430	1,350	590	250	430	1,080	290	340	1,340
	Cowpeas in unmanured rotation	223	480	550	980	500	260	650	900	815	710	1,175
Cowpea hay, pounds	Milo in manured rotation [2]	273	600	1,080	1,320	1,120	600	1,500	1,100	510	330	2,060
	Milo in unmanured rotation	223	1,240	1,050	1,040	1,140	600	1,600	1,140	850	530	2,060
	Cotton in manured rotation [2]	272	1,380	1,060	1,500	1,220	600	1,620	1,640	600	390	1,960
	Cotton in unmanured rotation	222	1,480	1,020	1,100	1,160	580	1,400	1,740	440	420	1,700

Crop	Previous crop and manure treatment	Rotation No.	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945
Milo grain, bushels	Manured fallow	273	8.6	23.1	47.2	31.6	29.8	50.9	22.4	24.7	21.2	51.7
	Unmanured fallow	223	10.9	27.6	37.1	35.9	36.4	51.0	35.9	28.4	23.3	42.8
	Cowpeas in manured rotation [1]	272	20.3	19.5	36.7	18.3	20.5	54.1	20.0	22.4	18.6	58.6
	Cowpeas in unmanured rotation	222	5.0	13.4	31.0	15.3	9.1	49.0	18.8	21.2	10.9	44.7
Seed cotton, pounds	Manured fallow	272	510	1,090	710	1,230	1,360	1,260	810	640	700	750
	Unmanured fallow	222	330	990	700	990	1,130	1,190	530	630	740	860
	Cowpeas in manured rotation [1]	273	140	630	740	650	680	1,080	130	550	540	800
	Cowpeas in unmanured rotation	223	380	1,010	880	760	980	1,210	250	650	810	680
Cowpea hay, pounds	Milo in manured rotation [2]	273	700	1,100	5,000	2,300	1,670	3,300	1,060	2,500	1,500	3,000
	Milo in unmanured rotation	223	840	1,340	4,000	2,000	1,660	3,500	1,190	2,400	1,400	2,600
	Cotton in manured rotation [2]	272	1,210	1,600	4,800	2,200	1,660	3,900	960	2,200	1,900	3,900
	Cotton in unmanured rotation	222	740	1,040	4,300	1,600	1,400	3,300	780	1,800	1,500	3,000

Crop	Previous crop and manure treatment	Rotation No.	1946	1947	1948	1949	1950	1951	1952	1953	Average, 1916–53
Milo grain, bushels	Manured fallow	273	2.8	12.2	4.1	5.3	14.8	9.1	0	1.4	23.0
	Unmanured fallow	223	18.8	19.7	14.8	12.9	36.4	17.9	0	2.2	24.9
	Cowpeas in manured rotation [1]	272	4.0	6.9	11.9	14.0	28.3	.5	0	4.0	19.6
	Cowpeas in unmanured rotation	222	7.8	4.8	7.4	10.2	23.8	.7	0	1.9	18.4
Seed cotton, pounds	Manured fallow	272	800	740	530	500	1,260	630	0	160	792
	Unmanured fallow	222	4,000	640	430	400	810	650	0	150	704
	Cowpeas in manured rotation [1]	273	40	210	340	390	680	150	0	350	540
	Cowpeas in unmanured rotation	223	480	460	430	560	680	240	0	400	622
Cowpea hay, pounds	Milo in manured rotation [2]	273	310	500	860	800	2,900	400	0	0	1,454
	Milo in unmanured rotation	223	1,020	2,600	1,060	1,200	2,400	920	0	0	1,462
	Cotton in manured rotation [2]	272	430	2,600	2,620	1,000	3,200	800	0	0	1,658
	Cotton in unmanured rotation	222	450	2,200	1,890	1,100	2,900	840	0	0	1,485

[1] Third crop after manure was applied.
[2] Second crop after manure was applied.

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